CAMBRIDGE SYSTEMATICS
Transportation leadership you can trust.

Memorandum

TO: California High Speed Rail Authority Ridership and Revenue Forecasting Process Peer Review Panel

FROM: Cambridge Systematics, Inc.

DATE: June 8, 2011 (Revised)
March 31, 2011

RE: Information Requested in "Section 3.2 Validation and Documentation" of the Independent Peer Review of the California High Speed Rail Ridership and Revenue Forecasting Process, 2005-10, Draft Report for Internal Review (February 7, 2011)

This memorandum is a major revision to our original memorandum from March 31, 2011. The revisions are based on the May 2-3, 2011 meeting with the Peer Review Panel in San Francisco and the conference call with the panel on May 19, 2011. The original memo provided the additional summaries and analyses requested by the Peer Review Panel under Section "3.2 Validation and Documentation," in the Peer Review Panel Draft Report dated February 7, 2011. This version of the memorandum continues to address the ten bullet-point requests listed in the "Task 3.2 section" of the Peer Review Panel Draft Report in order.

Proposed Approach Moving Forward

This memorandum demonstrates that the existing California High Speed Rail Ridership and Revenue model ("HSR Model") exhibits reasonable sensitivities and can continue to be used for current business planning efforts that need to be completed this summer. This memorandum brings together the material presented at the May 2-3 meeting with the additional sensitivity testing and analyses that continued after that meeting at the request of the Peer Review Panel. The sensitivity testing material was reported to the Peer Review Panel on May 19.

Based on the results presented in this memo, we propose the following approach to forecasting moving forward:

1. Continue using the HSR Model for business plan forecasting runs, including alternative scenarios for HSR fares and frequencies, air fares and frequencies, and auto operating costs. This is consistent with prior plans.

2. Continue efforts to recalibrate and revalidate the HSR Model to observed 2008 conditions estimated form the newly-collected trip frequency survey data coupled with other network, ridership and count data. This is also consistent with prior plans.

140 East 19th Avenue, #400
Denver, CO 80203
tel 303-832-2998 www.camsys.com fax 303-825-1585

3. After the recalibration and revalidated of the HSR Model to 2008 conditions, use that version of the model ("2008 HSR Model") to test one or two scenarios that have been previously run for the purpose of creating adjustment factors on ridership and revenue. The results of this work would be incorporated into the ridership and revenue forecasts used for the CAHSRA's business plan.

Step three is a departure from previous plans, in that we propose skipping the step of incorporating the newly estimated "consensus model" (documented in separate memoranda) at this time. Our reason for proposing this approach is three-fold:

1. We have demonstrated that the existing model exhibits reasonable sensitivities.

2. While the re-estimated consensus model will incorporate theory and modeling approaches that are more satisfying to the Peer Review Panel and should provide additional sensitivity to the model, implementing the consensus model and then calibrating and validating the consensus model adds complexity to the existing business planning effort. This adds risk to our ability to deliver business planning forecasts on the needed schedule.

3. The consensus model will be incorporated in the next round of model revisions. Specifically, work on the consensus main mode choice model currently underway will continue with plans to calibrate and validate that model to 2008 conditions over the summer. Assuming the results of the consensus model calibration and validation are successful, that model will replace the mode choice model component in the HSR Model in the August-September 2011 timeframe.

Memo Overview

Major updates in this memorandum include:

- Revisions have been made to Section 2.2 c, "Tables and maps of long distance trips per day by person type (income, region of residence, etc.) and trip purpose**,"** to provide more information that more accurately represents the modeled geographic distributions of both short and long distance interregional trip frequencies. Graphics shown in the original draft memorandum were based on data "filtered" to represent only those trips made on interchanges with a high-speed rail path. Graphics shown in the this updated version of the memorandum are based on all travel regardless of whether or not a high speed rail path is available. In addition, a summary of annual round trips per capita has been provided. **[Pages 11-21].**

- Revisions have been made to Section 2.3 a, "Mode shares by network distance from HSR stations (distinguished among HSR stations with different access modes)," to provide additional understanding of how mode shares change with respect to access distance to HSR stations. Again, the original analyses focused on trips made on interchanges with a valid high speed rail path, which provided a distorted view of the mode shares by access distance. **[Pages 23-27].**

- Section 2.3 b, "Tables of own- and cross-elasticities by mode for the time and cost variables across the state, by origin-destination distance or inter-regional pairs, by income group and distance band from the HSR stations," has been completely replaced with the analyses provided to the Peer Review Panel in the May 19 meeting. **[Pages 27-38].**

Note that this memo deals exclusively with interregional travel.

1. Introductory paragraphs discussing model estimation, calibration, and validation

CS agrees with and will use the definitions of model estimation, calibration, and validation as described by the panel. We used these same basic definitions in the *Travel Model Validation and Reasonableness Testing Manual, Second Edition* recently published by the FHWA Travel Model Improvement Program. We trust that the panel understands that, while CS is supporting efforts to encourage general adoption of the definitions listed in the draft report, existing documentation was written prior to formal codification of these definitions and by professionals who were not necessarily familiar with the definitions.

We would also note that use of independent (and newer) data for model validation is a goal that is often difficult to achieve. Quite frequently, it is necessary to "validate" model components using the same data as was used for model estimation or calibration.

In April 2010, we suggested that new data be collected to provide for a temporal validation of the HSR Model. A long distance travel survey using a internet-based panel was designed and provided to the Peer Review Panel for review and comment in May. The survey collected detailed data on the most recent long distance trip and summary information for all long distance trips completed over the last two months. Data collection from over 15,000 respondents was completed June 6, 2011. The data are currently being analyzed and should provide up to date long distance trip frequency, origin-destination, and mode use information for California residents. The results will be used for the validation of the ridership and revenue HSR Model using 2008 input data.

2. Requested summaries and analyses

2.1 For the calibration year only

- Maps, graphs, and tabular summaries of statistical measures of the deviation between assignment results and observed modal flows (road, air, rail)
- Tabular summaries of comparison of assigned versus observed screenline volumes

Tables 1 through 3 show results from the year 2000 HSR Model validation as summarized in the report, *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study: Statewide Model Validation, Final Report.* Table 1 summarizes results for statewide air passenger trips for major region-to-region air interchanges.

Table 1. Year 2000 Air Passenger Flow Validation

Market	Observed Adjusted	Model	Difference	Percent Difference
Los Angeles – Sacramento	12,308	12,170	-138	-1%
Los Angeles – San Diego	387	70	-317	-82%
Los Angeles – San Francisco	29,329	28,890	-439	-1%
Sacramento – San Francisco	8	22	14	175%
Sacramento – San Diego	3,848	5,030	1,182	31%
San Diego – San Francisco	8,096	8,263	167	2%
Los Angeles/San Francisco – San Joaquin Valley	140	137	-3	-2%
Other	1,040	294	-746	-72%
Total	55,156	54,876	-280	-1%

Source: Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study: Statewide Model Validation, Final Report, Table 6.5.

Table 2 summarizes boardings the conventional rail (CVR) services providing interregional service. The major CVR services carry both intra- and interregional travel. Since intra- and interregional trips cannot be indentified based on the observed boarding counts, only the total boardings can be compared.

Table 2. Year 2000 Conventional Rail Passenger Boarding Validation

Service	Observed	Intra-regional Models	Inter-regional Model	Total Trips	Difference	Percent Difference
Altamont Commuter Express	3,100	836	451	1,287	-1,813	-58%
Amtrak Surfliner	5,100	2,966	5,122	8,088	2,988	59%
Amtrak San Joaquin	2,110	452	2,350	2,802	692	33%
Amtrak Capital Corridor	3,300	1,094	1,872	2,966	-334	-10%
Total	13,610	5,348	9,795	15,143	1,533	11%

Source: Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study: Statewide Model Validation, Final Report, Table 6.6.

Table 3 summarizes the statewide traffic assignment results. A map of the 14 regions referenced in Table 3 is shown in Figure 1. A major focus of the traffic assignment validation was vehicle miles of travel on links with counts. The six gateways established for the validation represented key corridors for high speed rail (HSR). All modeled gateway traffic volumes were within ±15 percent of observed traffic volumes.

Table 3. Year 2000 Traffic Assignment Validation

Classification	Locations	Observed	Model	Difference	Percent Difference
Vehicle Miles Traveled By Facility Type					
Freeways/Expressways	1,155	54,807,094	55,666,538	859,443	2%
Major Arterials	179	2,760,912	3,764,260	1,003,348	36%
Minor Arterials/Collectors	25	144,513	148,993	4,422	3%
Total	**1,359**	**57,712,519**	**59,579,791**	**1,867,213**	**3%**
Vehicle Miles Traveled By Area Type					
Rural	836	29,959,583	28,096,076	(1,863,506)	-6%
Suburban	133	4,321,742	4,784,532	462,790	11%
Urban	390	23,431,194	26,699,182	3,267,987	14%
Total	**1,359**	**57,712,519**	**59,579,791**	**1,867,271**	**3%**
Vehicle Miles Traveled By Region					
AMBAG	39	2,166,435	1,572,883	(593,552)	-27%
Central Coast	70	1,756,734	3,054,418	1,297,684	74%
Far North	258	4,684,264	6,763,302	2,079,038	44%
Fresno	46	2,470,711	2,150,050	(320,661)	-13%
Kern	83	3,731,189	3,342,222	(388,967)	-10%
Merced	64	2,092,094	1,717,837	(374,257)	-18%
MTC	176	7,975,231	7,653,524	(321,707)	-4%
SACOG	150	8,416,323	8,495,630	79,308	1%
San Joaquin	90	3,328,091	3,997,801	669,710	20%
SANDAG	141	15,417,924	15,186,348	(231,576)	-2%
SCAG	16	638,858	466,960	(171,898)	-27%
South San Joaquin	20	778,733	697,951	(80,782)	-10%
Stanislaus	44	1,423,711	1,690,356	266,645	19%
W. Sierra Nevada	162	2,832,222	2,790,509	(41,713)	-1%
Total	**1,359**	**57,712,519**	**59,579,791**	**1,867,271**	**3%**
Volumes By Gateway					
Sacramento – San Francisco on I-80	4	115,536	127,788	12,252	11%
Sacramento – San Joaquin Valley (I-5 and SR-99)	4	109,365	112,105	2,740	3%
San Joaquin Valley – San Francisco on I-580	4	111,500	95,831	(15,669)	-14%
San Joaquin Valley – San Francisco on SR-152	2	20,728	17,705	(3,023)	-15%
San Joaquin Valley – Los Angeles on I-5 and SR-14	4	78,927	86,910	7,983	10%
Los Angeles – San Diego on I-5 and I-15	4	442,951	451,154	8,203	2%
Total	**22**	897,651	891,491	(6,160)	-1%

Source: Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study: Statewide Model Validation, Final Report, Table 6.7.

Figure 1. California Urban Areas and HSR Station Locations

2.2 *For both calibration and forecast years*

The data summarized in this section are from the 2000 calibration/validation results; 2030 forecast summaries are from the May 2009, full-system operating plan.

a. Overall mode shares by origin-destination distance:

Figures 2 and 3 show modeled mode shares by trip distance for 2000 and 2030, respectively. Auto skim distances were used as the trip distance basis for the summaries shown in the figures. The mode shares shown in the figures were developed by summing modeled trips into 25-mile bins. While shown as line graphs, the data summarized were actually histograms. Note that the mode shares for every 25-mile bin are shown in the figures even though labels for only every other were displayed on the x-axis.

Figure 2 shows the year 2000 mode shares by origin-destination distance and trip purpose for inter-regional trips. The year 2000 scenario does not include HSR. For business and commute trips, mode share for the year 2000 are dominated by auto for trips up to about 300 miles. For trip lengths in the 400-500 mile range, auto and air trips have close to equal mode shares. After 500 miles, auto begins to dominate again, however we believe trips over 500 miles are dominated by TAZ pairs with at least one TAZ located far from a major airport. For the recreation and other category, trips are predominantly made by auto for distances up to 300 miles. After 300 miles, air and auto are split almost equally. CVR trips garner a very low share of the overall market.

Figure 3 shows the year 2030 mode shares by origin-destination distance and trip purpose for inter-regional trips. For business and commute trips between 100 to 300 miles, HSR captures about 10-20 percent of the market share from auto trips, which dominated this distance in the year 2000 scenario. For business and commute trips over 300 miles, auto, air, and HSR compete closely with one another, with mode share split about evenly between the three modes. For recreation and other trips between 100 to 300 miles, HSR captures about 20-40 percent of the market share from auto trips, which dominated this distance in the year 2000 scenario. For recreation and other trips between 300 to 500 miles, HSR trips make up between 40-60 percent of the mode share, with auto and air competing closely for the rest of the share of trips. For trips greater than 500 miles, auto, air, and HSR represent the market evenly. Similar to 2000, CVR trips represent a very small portion of inter-regional trips.

Figure 2. Year 2000 Mode Shares by Origin-Destination Distance and Trip Purpose for Inter-regional Trips

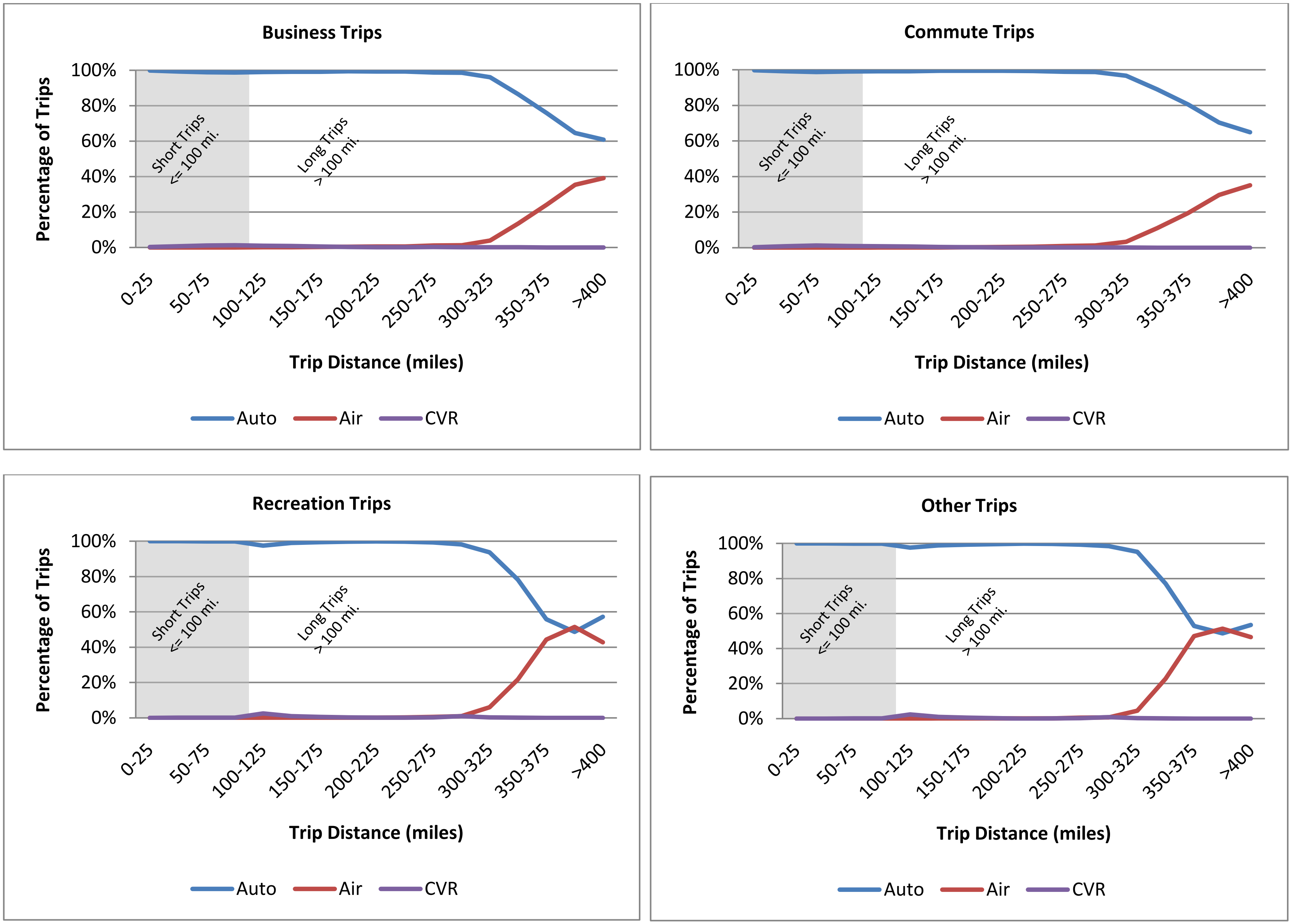
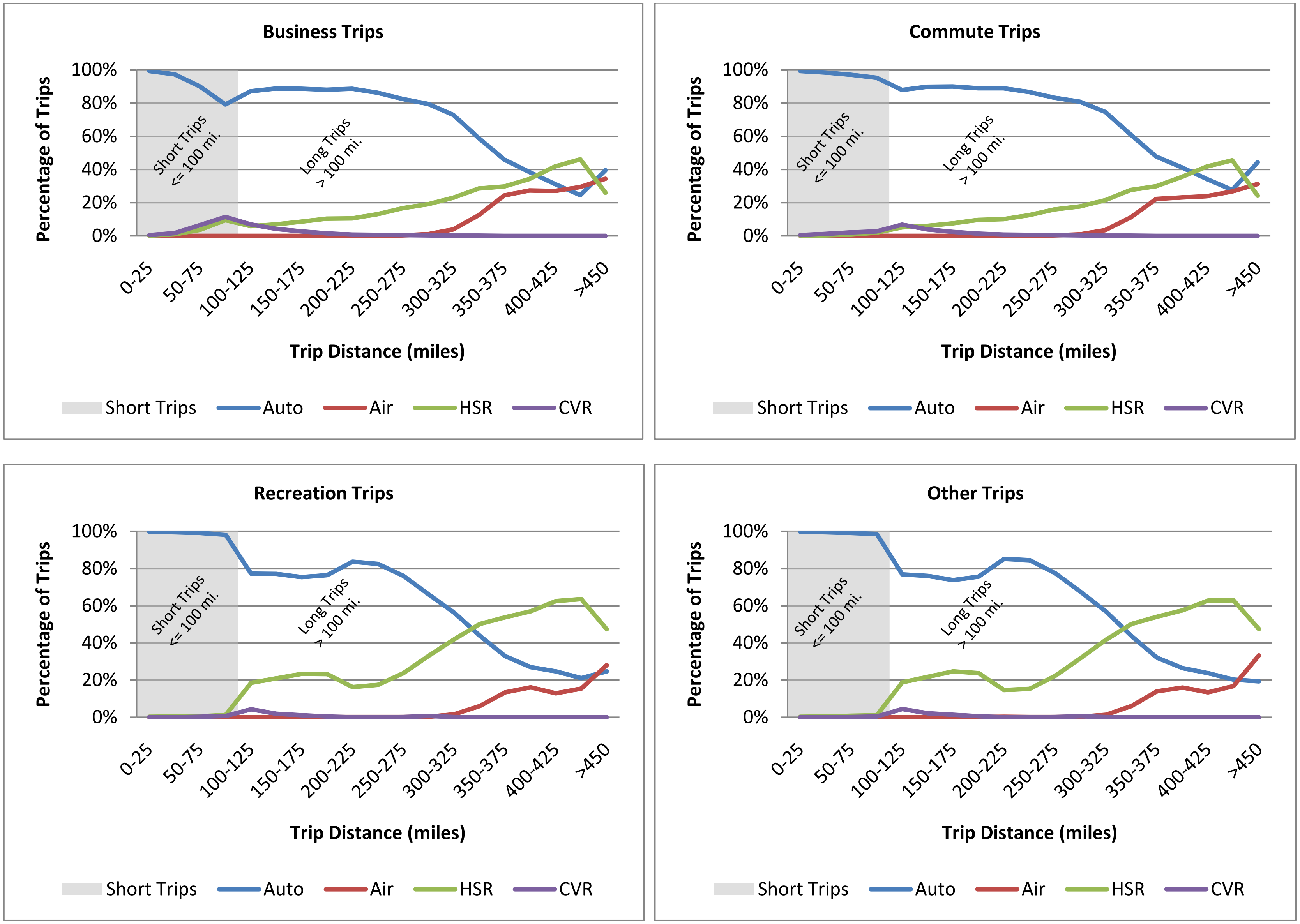


Figure 3. Year 2030 Mode Shares by Origin-Destination Distance and Trip Purpose for Inter-regional Trips



Cambridge Systematics

b. Mode shares by income:

Mode shares by income group cannot be produced without rewriting and recompiling the HSR Model application code. The existing code internally aggregates the TAZ-to-TAZ data to each of the four main modes (auto, air, CVR, and HSR) for each of the four trip purposes (business, commute, recreation, and other).

In order to provide some insight on the sensitivity of mode shares with respect to income, an example mode choice spreadsheet was developed to apply the main mode choice model and the access and egress mode choice models. The access and egress mode choice models were included in the example spreadsheet since information from those models feed the main mode choice model through access and egress logsum variables.

Representative interchanges for a long distance business/commute trip and for a short distance recreation/other trip were selected and the spreadsheet populated with the interchange and socioeconomic data for each of the two representative interchanges. Results for the three income groups for the two examples are shown in Table 4 to provide information regarding the impact of income on mode shares. The income group mode shares were calculated by averaging the mode shares across all other socioeconomic segmentation variables – household size, number of workers, and number of vehicles. Group size was set to represent a single person traveling alone for this example.

The main mode choice model for long distance business/commute trips includes positive high income dummy variables for the air, CVR, and HSR modes (1.18, 0.613, and 1.147, respectively). The greater disparity between HSR mode shares and between air mode shares for the high and middle income groups as compared to the differences between those shares for middle and low income reflect this model specification. Income also impacts the access and egress mode choice models through positive coefficients for some access egress modes for high income and negative coefficients for some modes for low income households. This indirect impact is then fed upward to the main mode choice model through the logsum variable.

Income level is not used in the main mode choice model for short distance recreation/other trips. This specification explains the lack of difference in mode choice shares across income groups. Income variables are included in the access and egress mode choice models. This indirect impact explains the small differences between low income and middle income household shares.

Table 4. Example Mode Shares by Income Group

	Long Distance Business/Commute Trip - SCAG to MTC Interchange			Short Distance Recreation/Other Trip - SCAG to SANDAG Interchange		
Main Mode	Low Income	Middle Income	High Income	Low Income	Middle Income	High Income
CAR	10.46%	9.98%	4.72%	90.55%	90.49%	90.49%
AIR	26.05%	26.45%	28.69%	0.00%	0.00%	0.00%
HSR	63.49%	63.57%	66.59%	6.36%	6.40%	6.40%
CVR	0.00%	0.00%	0.00%	3.10%	3.10%	3.10%

c. Tables and maps of long distance trips per day by person type (income, region of residence, etc.) and trip purpose:

Figures 4a-6b display information regarding the variation of interregional trips by geographic area throughout the state. Information is shown for both short interregional trips (less than 100 miles) and long distance interregional trips (greater than or equal to 100 miles) for 2000 total trips, 2030 total trips, and for 2030 trips made by HSR. Daily trip rates per household have been displayed with trips being defined as one-way movements, not round trip journeys[1]. As noted previously, the existing HSR Model application code does not output data by income group. Thus, only total rates by region-of-residence have been displayed in Figures 4a-6b. TAZ-specific information is displayed in the figures to provide an idea of intraregional variation; geographic regions are outlined on the figures for orientation purposes (see Figure 1 for region definitions).

Figure 4a shows the total short distance interregional trips per household per day for 2000; Figure 5a shows the same information for 2030. In 2000, households in a substantial portion of the state made between 0.00 and 0.25 short distance interregional trips per day. There are some areas with higher short distance rates near the regional boarders where they would be expected to occur. In addition, there are several small areas (possibly TAZs) where the short distance intraregional rates are 1.0 or more per day. The high rates appear to be unreasonable but were probably caused by anomalies in the input data. As shown in Figure 5a, the extremely high rates do not occur in 2030. The 2030 short distance interregional trip rates are, in general, higher than 2000. However, the rates remain in the lowest, non-zero, range in the highly developed areas of the state: the Bay Area, Los Angeles region, San Diego, and Sacramento.

Figures 4b and 5b show the total long distance interregional trips per household per day for 2000 and 2030, respectively. In 2000, the long distance trip rates are generally higher in the more remote areas of the state. Again, like the short distance trip rates, the 2030 long distance trip rates shown in Figure 5b are generally higher than the 2000 long distance trip rates shown in Figure 4b.

Figure 6a shows the total short distance interregional HSR trips per household per day for 2030 and Figure 6b shows the total long distance HSR trip rates. As should be expected, the short distance trip rates are higher around the planned HSR stations. The higher long distance HSR trip rates are more dispersed around the planned HSR system but continue to reflect a logical pattern.

In general, the patterns of trip rates shown in Figures 4a-6b display generally logical variation by geographic area. While there are some anomalies, they occur for 2000, not 2030. This leads us to suspect that there were changes made to the 2000 socioeconomic data after the 2000 model runs were produced.

[1] Annual per capita round trip journeys can be approximated from the daily household trip rates by dividing by 2 to convert one-way trips to round trip journeys, dividing that result by the average household size (2.65 is a reasonable statewide approximation for both 2000 and 2030), and multiplying by 365 to convert daily to annual trips. These conversions can be approximated by multiplying the daily household trip rates by 70 to estimate annual per capita round trip journeys.

Figure 4a. Year 2000 Average Total Short Distance Interregional Trips per Household per Day

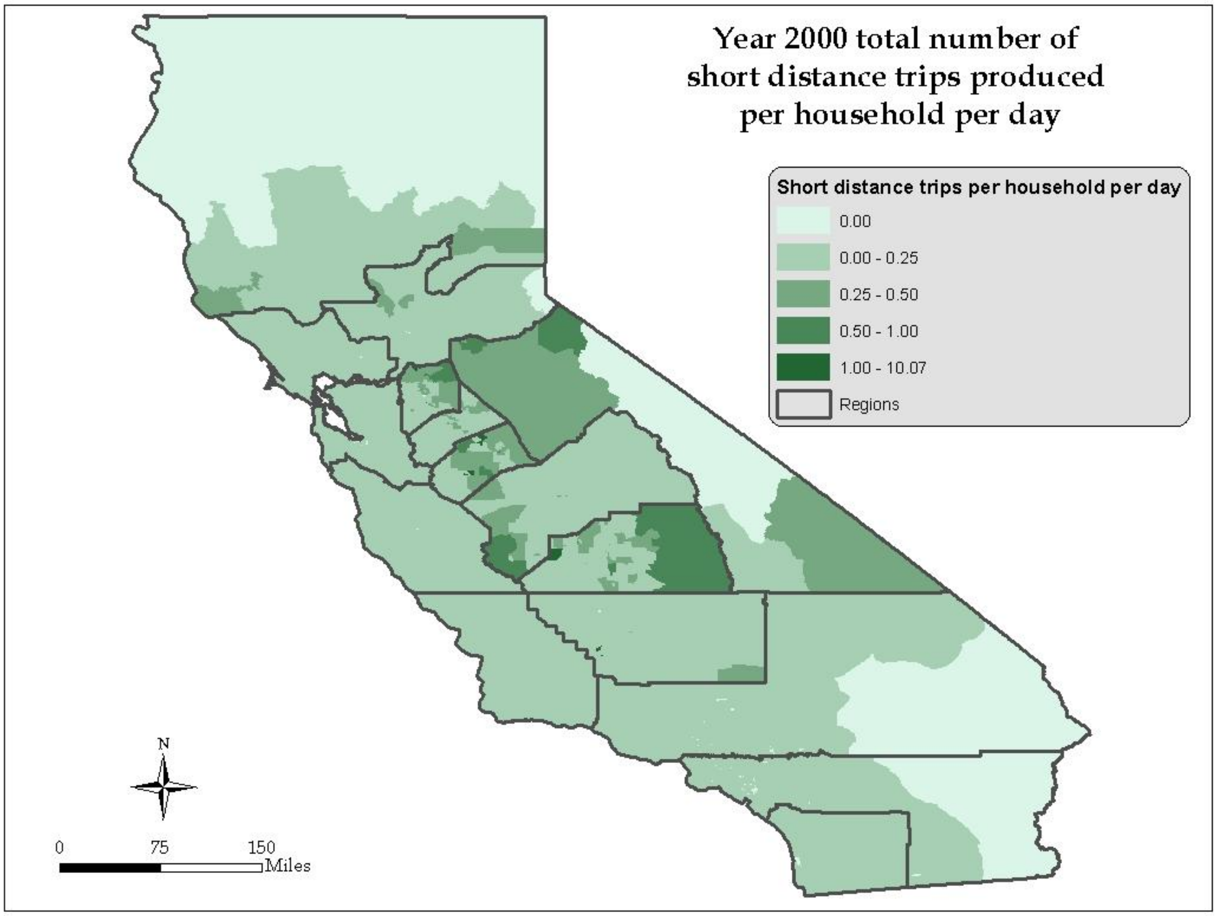


Figure 4b. Year 2000 Average Total Long Distance Interregional Trips per Household per Day

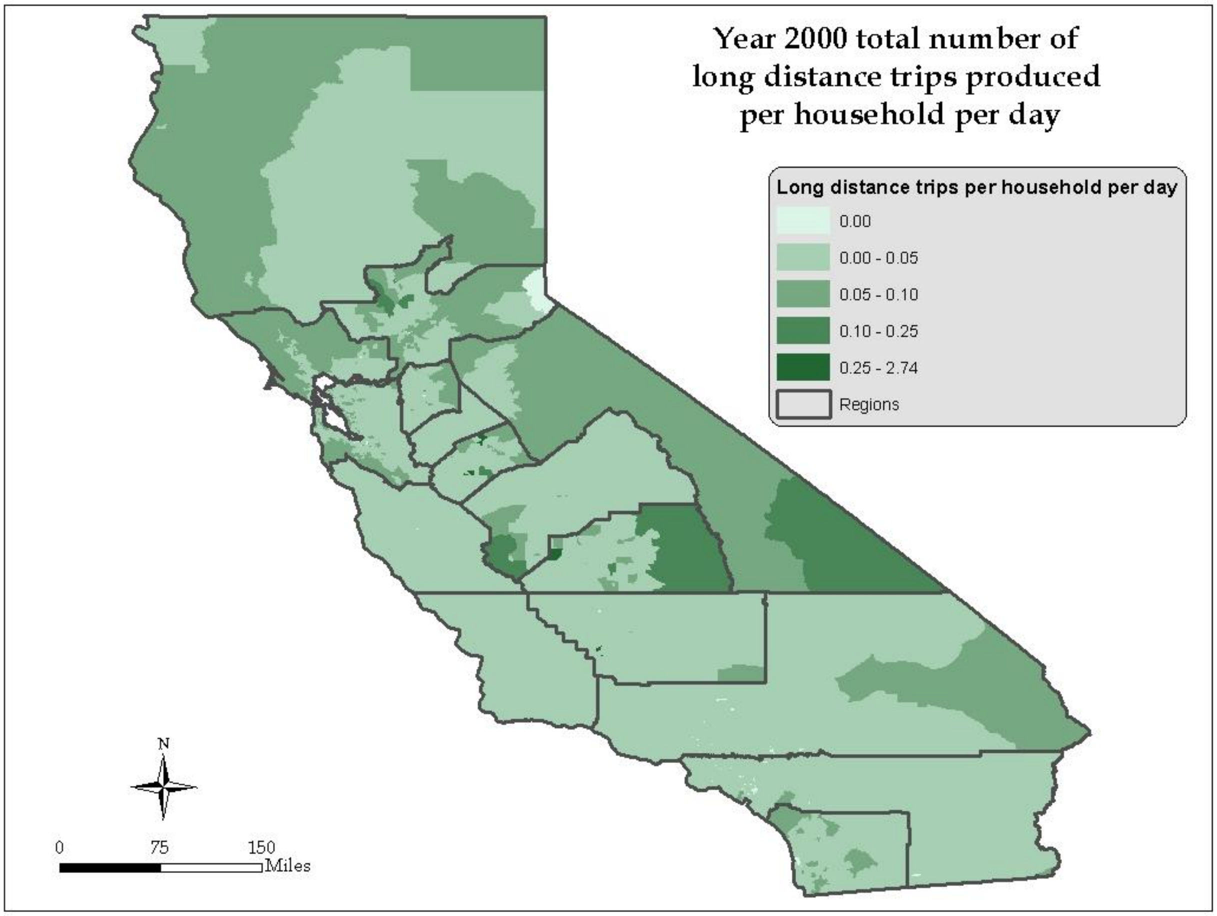


Figure 5a. Year 2030 Average Total Short Distance Interregional Trips per Household per Day

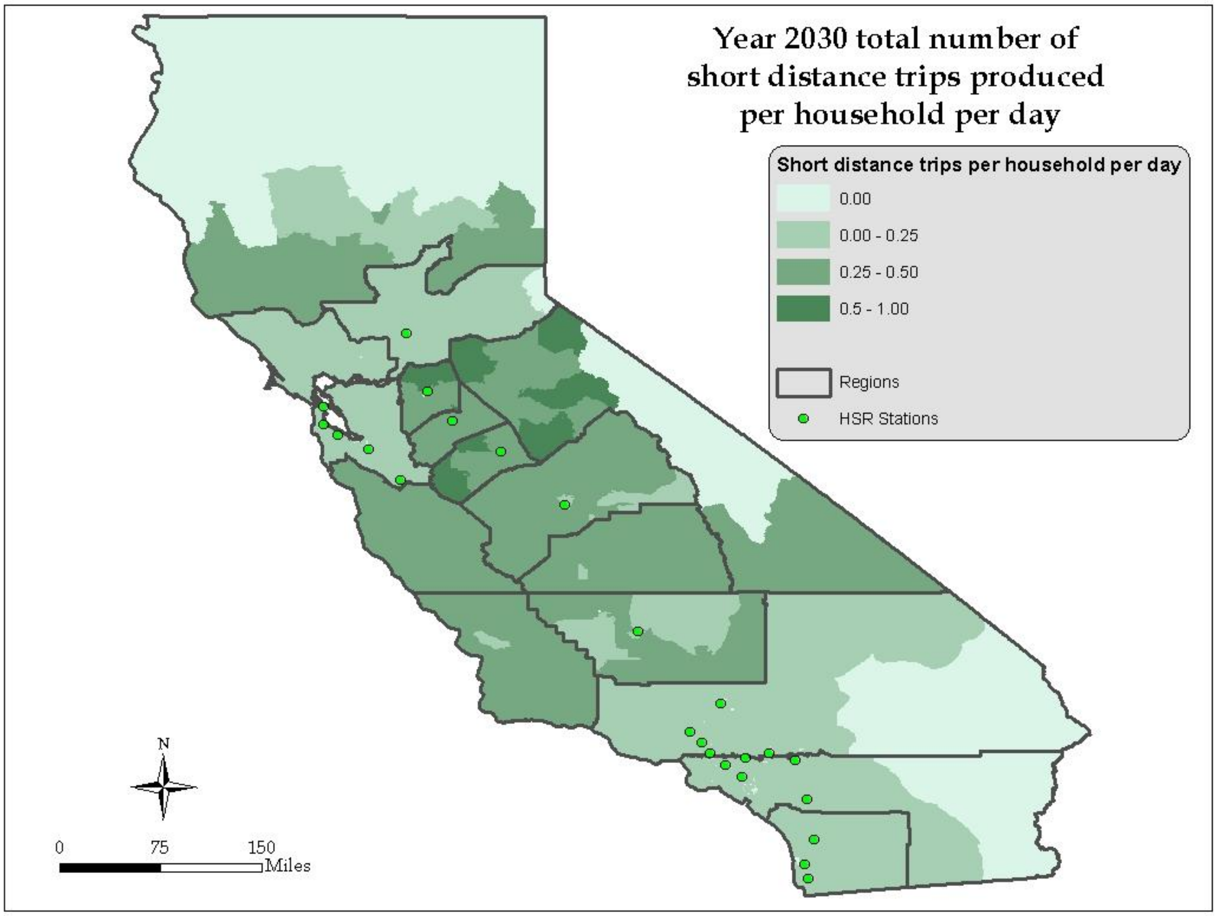


Figure 5b. Year 2030 Average Total Long Distance Interregional Trips per Household per Day

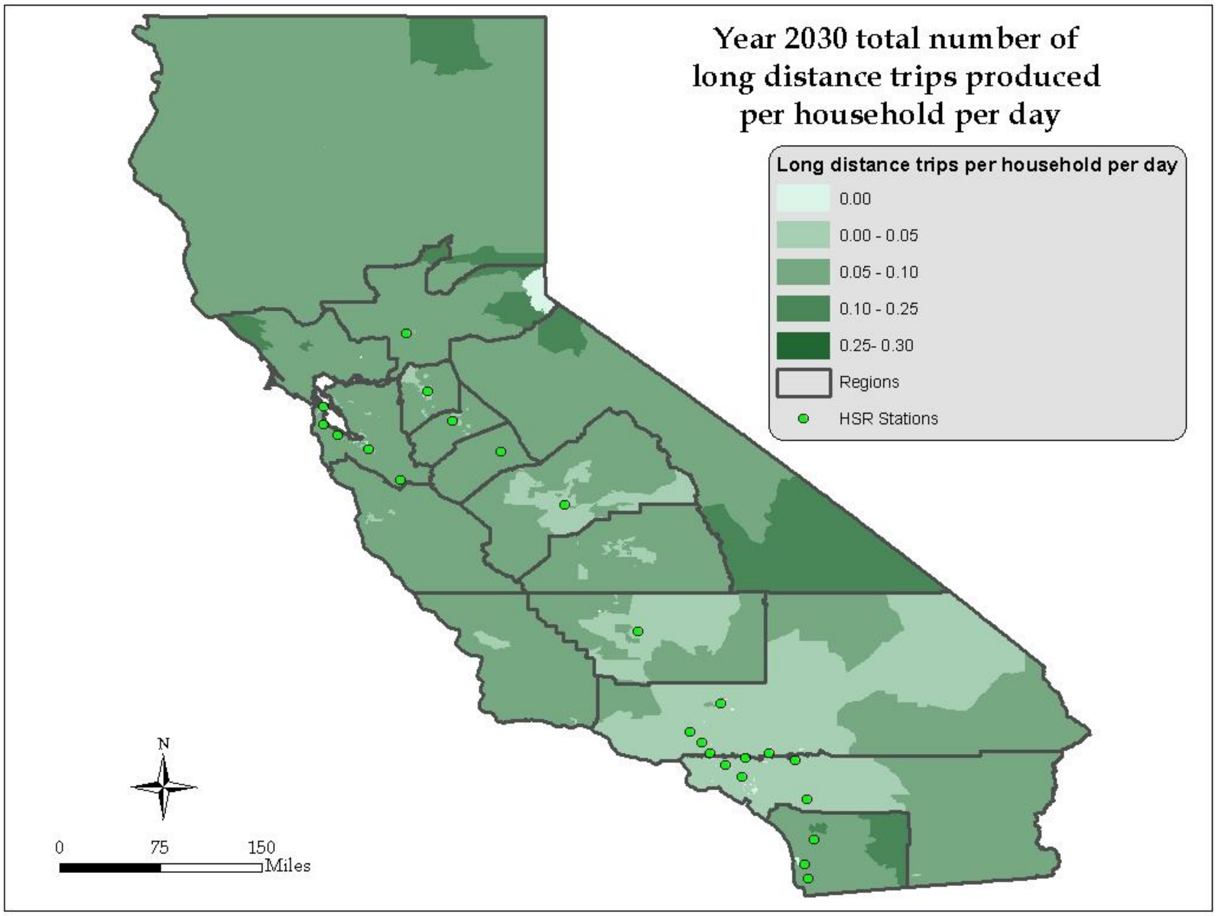


Figure 6a. Year 2030 Average Total Short Distance Interregional Trips on HSR per Household per Day

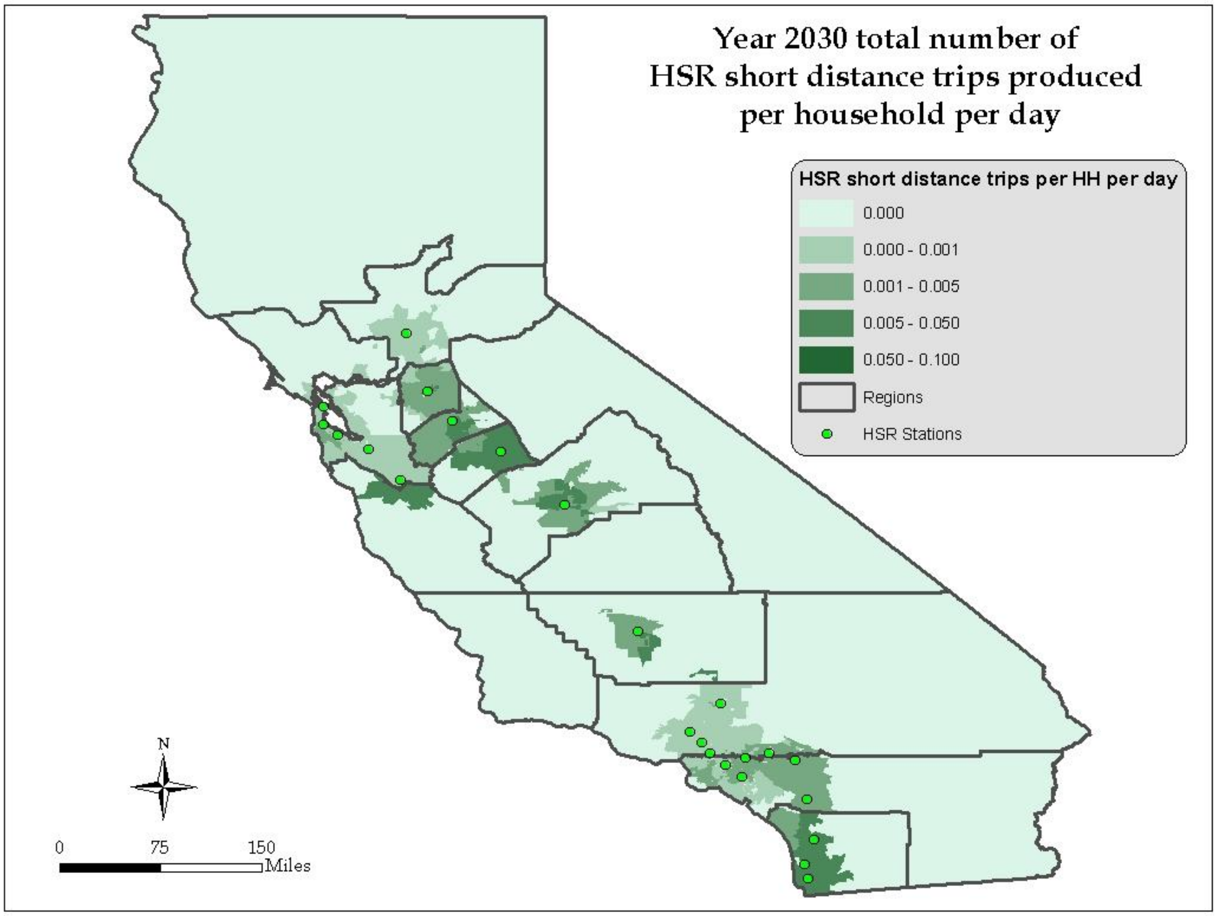


Figure 6b. Year 2030 Average Total Long Distance Interregional Trips on HSR per Household per Day

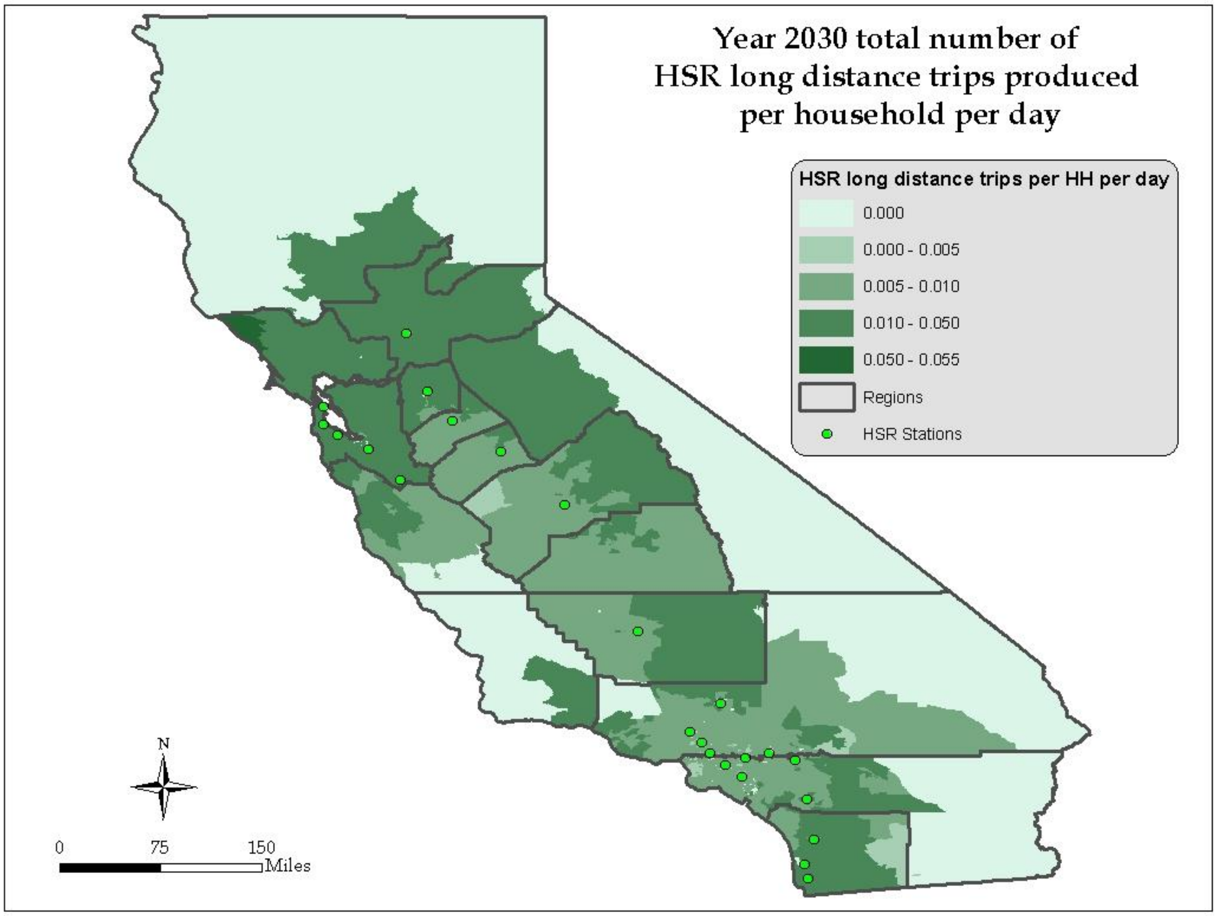


Table 5 summarizes the purpose-specific long distance average annual round trip journeys per capita for each of the 14 regions in the state for 2000 and Table 6 summarizes the information for 2030. In effect, Tables 5 and 6 provide quantitative results from the trip frequency model for long distance travel.

The long distance trip frequency model considers local and regional accessibility, long distance accessibility as represented by the destination choice logsums, and household composition (e.g. income level, household size, number of workers, and number of autos per worker). As long distance accessibility increases, the frequency of long distance trips increases. Conversely, as regional accessibility increases, the number of long distance trips decreases.

Tables 5 and 6 show that the average statewide interregional long distance trip making is relatively stable between 2000 and 2030. The statewide average interregional long distance trip frequency increases by about nine percent from 2000 to 2030 with recreation and other trip making increasing the most (11 percent and 18 percent, respectively) and business and commute increasing at lower rates (4 percent and 7 percent, respectively). The statewide increase in long distance trip making appears to be driven by the largest, most populous regions in the state: SACOG, MTC, SCAG, and SANDAG. The other regions in the state generally display decreasing long distance trip making. The distribution of trips by trip purpose for the state is stable for the two years with business and commute contributing about one-half of the per capita trip making and recreation and travel contributing the other one-half.

Figures 7a and 7b show the geographic distributions of HSR mode shares for short and long distance trips. The geographic distributions appear to be reasonably clustered around the HSR service.

Table 5. Average Annual Interregional Long Distance Round Trip Journeys per Capita by Geographic Area – 2000

Region	Business	Commute	Recreation	Other	Total
AMBAG	0.71	2.88	0.38	0.01	3.99
Central Coast	0.73	3.02	0.47	0.01	4.24
Far North	0.79	3.48	0.76	0.02	5.06
Fresno	0.52	2.29	0.41	0.01	3.24
Kern	0.60	2.56	0.53	0.03	3.72
Merced	0.60	2.65	0.49	0.02	3.76
MTC	0.75	3.22	0.60	0.03	4.60
SACOG	0.77	2.25	1.95	0.62	5.59
San Joaquin	0.44	1.53	1.52	0.49	3.99
SANDAG	0.64	2.62	0.47	0.25	3.98
SCAG	0.64	2.70	0.44	0.01	3.79
South San Joaquin	1.14	4.82	0.99	0.03	6.98
Stanislaus	0.24	0.45	2.75	0.47	3.91
W. Sierra Nevada	0.28	0.59	0.66	0.19	1.72
Statewide Average	**0.38**	**1.11**	**1.21**	**0.27**	**2.96**

Table 6. Average Annual Interregional Long Distance Round Trip Journeys per Capita by Geographic Area – 2030

Region	Business	Commute	Recreation	Other	Total
AMBAG	0.69	2.75	0.34	0.01	3.79
Central Coast	0.67	2.79	0.42	0.01	3.89
Far North	0.74	3.22	0.66	0.02	4.65
Fresno	0.49	2.10	0.35	0.01	2.95
Kern	0.55	2.26	0.41	0.02	3.24
Merced	0.53	2.32	0.40	0.01	3.26
MTC	0.69	2.88	0.48	0.03	4.08
SACOG	0.84	2.93	2.39	0.65	6.82
San Joaquin	0.46	1.57	1.93	0.66	4.63
SANDAG	0.60	2.44	0.40	0.20	3.64
SCAG	0.56	2.33	0.37	0.01	3.27
South San Joaquin	1.02	4.30	0.87	0.03	6.22
Stanislaus	0.27	0.50	3.15	0.54	4.46
W. Sierra Nevada	0.28	0.56	0.91	0.28	2.02
Statewide Average	**0.39**	**1.19**	**1.34**	**0.32**	**3.23**

Figure 7a. Year 2030 Average HSR Mode Share of Short Distance Interregional Trips

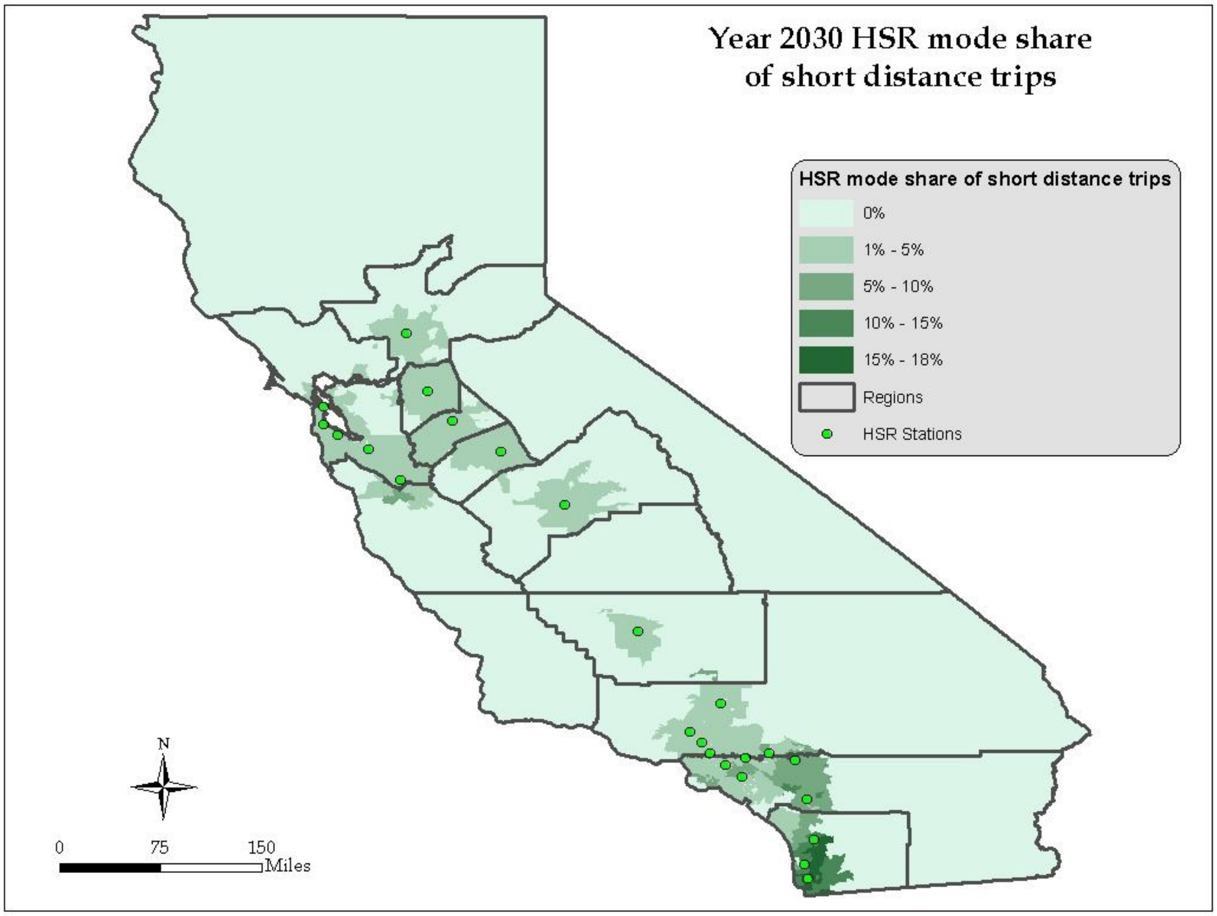
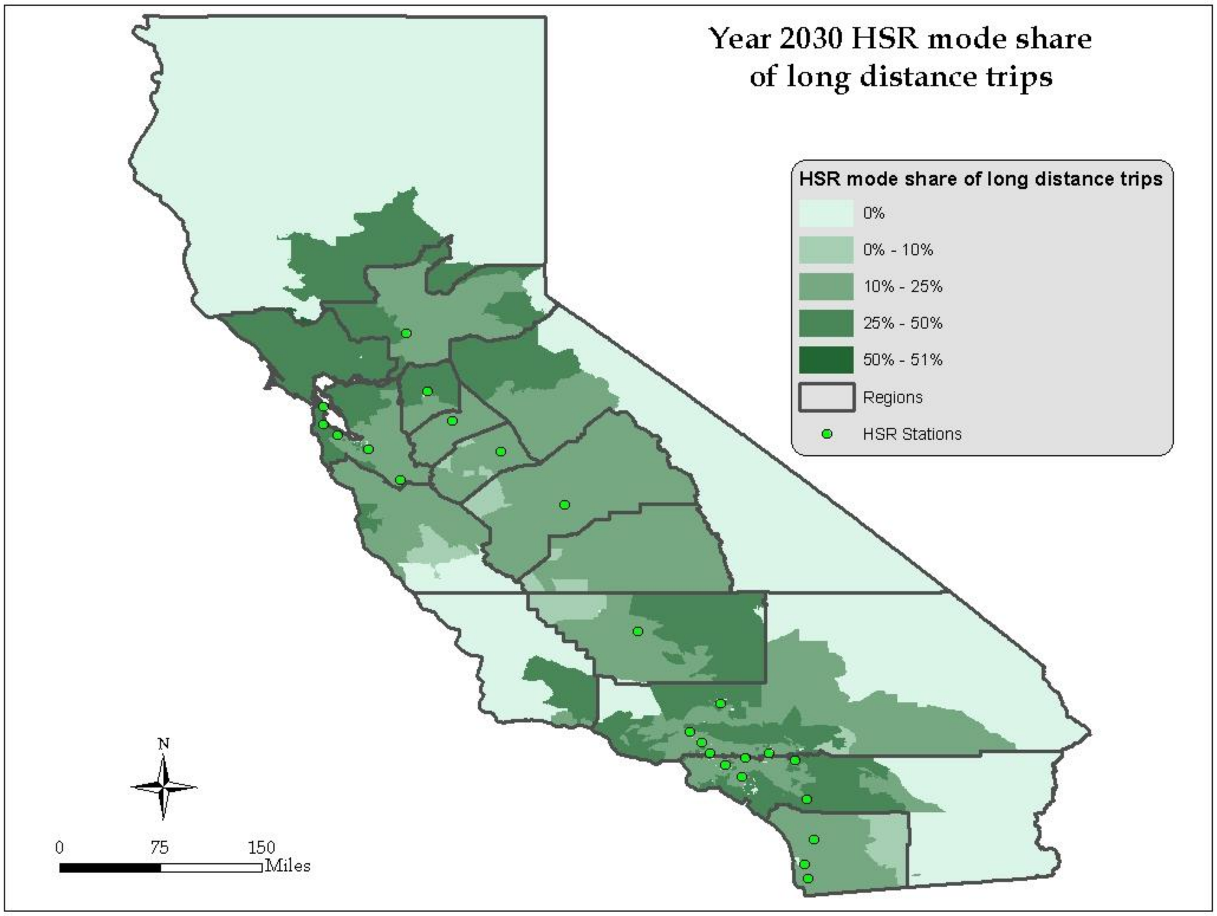


Figure 7b. Year 2030 Average HSR Mode Share of Long Distance Interregional Trips



d. Summary of income elasticities by mode

As noted previously, the existing HSR Model application code does not output data by income group. Thus, we demonstrated the sensitivity of mode choice to income with example interchanges using a spreadsheet implementation of the mode choice model. In addition, incomes are input as categorical variables; in mode choice, the trips are stratified into groups defined by travelers from low-, middle-, or high-income households. Thus, elasticity with respect to income, per se, cannot be calculated.

The HSR Model directly considers household income levels in the trip frequency and destination choice components. When the mode choice component was estimated, it was discovered that distance was a far more important variable than income. Thus, rather than stratifying the model to estimate different coefficients for travel cost by income group, the short-long trip stratification was used. In several of the purpose-specific models, income group-specific constants were used to improve the HSR Model results.

While income group-specific coefficients of cost can be used with coefficients of travel time to calculate values of time, the varying coefficients of cost really represent travelers' willingness to pay for premium modes of travel. For business related travel, it can be hypothesized that willingness to pay is less of an issue since much of the travel is subsidized or reimbursed by the travelers' businesses or clients. For commute trips, willingness to pay may be more important for frequency of travel and destination choice than mode choice. For recreation and other travel, willingness to pay may be a consideration but, at the same time, choice of mode may be part of the "adventure" captured in travel for those purposes.

While the above hypotheses provide possible explanations regarding why significant differences in coefficients of cost by income group were not found in the original HSR Model estimation, we are currently looking into alternative mode choice model formulations that directly consider different income levels. It is possible that meaningful relationships can be found that can be incorporated into a second generation of the travel model.

For frequency of travel, a general rule of thumb is that more trips are made for all trip purposes as incomes increase. The one exception to this rule we found is that high-income households tend to make fewer long distance recreation trips than low or middle income households, all other considerations being equal. For the HSR Model, however, this rule exception might be tempered by the fact that the model considers only intra-California trips, and wealthier people may make more out-of-state trips.

Values of time, as determined from the ratios of the coefficients of time to the coefficients of travel cost, vary by trip purpose. The implied values of time (in 2005 dollars) estimated from the main mode choice model coefficients of travel time and travel cost are shown in Table 7. The values of time for long distance interregional travel are substantially higher than values of time for typical urban area models. The values of time for short distance interregional travel are substantially lower than those for long distance travel. The short distance interregional values of time are reasonably close to typical values of time estimated for urban area models at least for commute and recreation / other travel. High values of time for business travel probably reflect subsidies or reimbursements of travel costs paid by employers or others.

Table 7. Implied Values of Time (in 2005 Dollars) for Interregional Trips

	Long Distance		Short Distance		
Coefficient / Variable	**Business / Commute**	**Recreation / Other**	**Business**	**Commute**	**Recreation / Other**
Coefficient of Cost (per Dollar)	-0.017	-0.035	-0.109	-0.148	-0.108
Coefficient of Time (per minute)	-0.018	-0.011	-0.050	-0.025	-0.014
Implied Value of Time	$63.64	$18.45	$27.60	$10.12	$7.95

2.3 For forecast years only

a. Mode shares by network distance from HSR stations (distinguished among HSR stations with different access modes)

Tables 8 and 9 show average interregional mode shares by trip purposes by access distance to HSR stations for short and long trips, respectively. The mode shares are the production mode shares for all TAZs within the specified access distance band from an HSR station to all TAZs throughout the state. Note that the maximum access and egress distances for airports and HSR stations is 100 miles; the maximum distances for CVR stations is 50 miles.

The access distance to a HSR station is based on the distance from the TAZ being analyzed to the closest HSR station to that TAZ. The closest HSR station was not necessarily the station used for the specific interchange being included in a summary. For example, the closest station to a TAZ might have been 5 miles away but out of direction for the trip being summarized. For this example, the actual HSR station used for the trip may have been 11 miles away, but in the direction of travel. Nevertheless, the trip would have been summarized in the 0-10 mile range for "Distance to HSR Station." All trips have been included in the analyses, not just trips on interchanges with a valid HSR path.

Table 8 shows HSR mode shares for short interregional trips, those under 100 miles in length. The mode shares behave as would be expected for the varying access distances to HSR stations: HSR main mode shares decrease as the access distance to the nearest HSR station increases. Such behavior demonstrates the decreased utility of using HSR for increasingly small portions of trips.

Tables 9a and 9b provide similar summaries to those in Table 8 except for long distance interregional trips. The summaries in Tables 9a and 9b have been stratified by the overall interchange distance as well as trip purpose. The HSR main mode shares by distance to a HSR station for trips between 100 and 200 miles in total length show patterns similar to those for short trips: HSR main mode shares decrease as the access distance to the nearest HSR station increases. This behavior continues to demonstrate the decreased utility of using HSR for increasingly small portions of trips.

Table 8. Average Interregional Mode Shares by Access Distance to a High Speed Rail Station for Short Trips

Trip Purpose	Distance to HSR Station (miles)	Main Travel Mode			
		Auto	Air	CVR	HSR
Business	0-10	79.5%	0.0%	10.9%	9.6%
	10-25	83.8%	0.0%	9.5%	6.7%
	25-50	96.9%	0.0%	2.9%	0.2%
	50-100	98.0%	0.0%	2.0%	0.0%
Commute	0-10	94.6%	0.0%	3.2%	2.1%
	10-25	96.2%	0.0%	2.5%	1.4%
	25-50	98.5%	0.0%	1.2%	0.3%
	50-100	98.9%	0.0%	1.1%	0.0%
Recreation	0-10	97.8%	0.0%	0.7%	1.5%
	10-25	98.9%	0.0%	0.4%	0.8%
	25-50	99.8%	0.0%	0.1%	0.1%
	50-100	100.0%	0.0%	0.0%	0.0%
Other	0-10	98.3%	0.0%	0.4%	1.3%
	10-25	99.0%	0.0%	0.2%	0.8%
	25-50	99.9%	0.0%	0.0%	0.1%
	50-100	100.0%	0.0%	0.0%	0.0%

Table 9a. Average Interregional Mode Shares by Access Distance to a High Speed Rail Station for Long Business and Commute Trips

Trip Purpose	Total Trip Length (Miles)	Distance to HSR Station (miles)	Main Travel Mode			
			Auto	Air	CVR	HSR
Business	100-200	0-10	86.0%	0.0%	6.0%	7.9%
		10-25	86.9%	0.0%	5.8%	7.2%
		25-50	89.9%	0.0%	3.5%	6.6%
		50-75	95.5%	0.0%	2.2%	2.3%
		75-100	99.3%	0.0%	0.4%	0.3%
	200-300	0-10	82.1%	0.4%	0.6%	16.9%
		10-25	82.1%	0.4%	0.5%	17.0%
		25-50	81.4%	0.2%	0.8%	17.5%
		50-75	84.3%	0.0%	0.4%	15.2%
		75-100	98.5%	0.3%	0.2%	1.1%
	300+	0-10	34.9%	35.1%	0.0%	30.0%
		10-25	33.5%	33.9%	0.0%	32.6%
		25-50	36.9%	17.5%	0.1%	45.4%
		50-75	39.0%	4.1%	0.0%	56.9%
		75-100	72.2%	2.1%	0.0%	25.7%
Commute	100-200	0-10	86.6%	0.0%	5.8%	7.6%
		10-25	87.7%	0.0%	5.9%	6.5%
		25-50	90.9%	0.0%	3.3%	5.8%
		50-75	95.4%	0.0%	2.4%	2.2%
		75-100	99.2%	0.0%	0.4%	0.3%
	200-300	0-10	82.3%	0.4%	0.7%	16.5%
		10-25	82.4%	0.5%	0.6%	16.5%
		25-50	81.8%	0.2%	0.9%	17.1%
		50-75	84.7%	0.0%	0.5%	14.8%
		75-100	98.6%	0.3%	0.2%	0.9%
	300+	0-10	36.0%	34.4%	0.0%	29.6%
		10-25	35.0%	32.9%	0.0%	32.0%
		25-50	39.4%	16.3%	0.1%	44.1%
		50-75	40.4%	3.7%	0.0%	55.9%
		75-100	70.4%	2.5%	0.0%	27.2%

Table 9b. Average Interregional Mode Shares by Access Distance to a High Speed Rail Station for Long Recreation and Other Trips

Trip Purpose	Total Trip Length (Miles)	Distance to HSR Station (miles)	Main Travel Mode			
			Auto	Air	CVR	HSR
Recreation	100-200	0-10	73.8%	0.0%	4.7%	21.5%
		10-25	77.2%	0.0%	2.3%	20.4%
		25-50	81.3%	0.0%	0.3%	18.4%
		50-75	94.6%	0.0%	0.0%	5.4%
		75-100	99.3%	0.0%	0.0%	0.7%
	200-300	0-10	74.1%	0.1%	0.2%	25.6%
		10-25	79.5%	0.2%	0.2%	20.1%
		25-50	77.0%	0.1%	0.1%	22.7%
		50-75	73.1%	0.0%	0.0%	26.9%
		75-100	97.4%	0.1%	0.0%	2.5%
	300+	0-10	25.0%	21.2%	0.0%	53.8%
		10-25	27.7%	18.1%	0.0%	54.2%
		25-50	28.1%	15.0%	0.1%	56.9%
		50-75	25.8%	11.2%	0.0%	63.0%
		75-100	56.7%	7.9%	0.0%	35.4%
Other	100-200	0-10	73.7%	0.0%	4.8%	21.4%
		10-25	76.2%	0.0%	2.5%	21.3%
		25-50	81.0%	0.0%	0.4%	18.7%
		50-75	95.9%	0.0%	0.0%	4.1%
		75-100	99.8%	0.0%	0.0%	0.2%
	200-300	0-10	76.4%	0.2%	0.2%	23.3%
		10-25	81.3%	0.2%	0.2%	18.3%
		25-50	80.2%	0.1%	0.1%	19.5%
		50-75	75.1%	0.0%	0.0%	24.8%
		75-100	94.3%	0.0%	0.0%	5.6%
	300+	0-10	24.4%	23.0%	0.0%	52.6%
		10-25	26.3%	20.3%	0.0%	53.4%
		25-50	26.7%	16.8%	0.0%	56.5%
		50-75	26.0%	11.7%	0.0%	62.3%
		75-100	64.9%	3.4%	0.0%	31.7%

The modeled traveler behavior by distance to a HSR station for trips of 200 to 300 miles and trips of 300 or more miles shown in Tables 9a and 9b is somewhat less clear than that reflected for the short trips in Table 8 and long trips in the 100 to 200 miles range. For trips in the 200 to 300 miles range, HSR mode shares are relatively constant for TAZs up to 75 miles from a HSR station. HSR mode shares for trips between 75 and 100 miles from a HSR station decrease substantially from the shares noted for TAZs closer to a HSR station. This modeled traveler behavior might also reflect the decreasing utility of using HSR for "small" portions of trips. The lack of variation in main HSR mode shares for TAZs less than 75 miles from a HSR station suggests that, for those trips, the access "cost" is a relatively minor part of the total utility (or disutility) of the overall trip.

For trips of 300 or more miles in length, the HSR main mode shares by distance from a HSR station demonstrate a seemingly illogical pattern, at least for TAZs up to 75 miles from a HSR station. Specifically, the shares increase as the distance from a HSR station increases. The HSR mode shares for TAZs that are 75 to 100 miles from a HSR station drop substantially from the shares for TAZs between 50 and 75 miles from a HSR station.

Main mode competition must be considered in the analysis of the modeled mode share patterns. For trips in the 200 to 300 miles range, the main mode competition is between auto and HSR; air travel and CVR carry very small shares of the total travel. Like HSR stations, relatively few airports are available to travelers. It is likely that the distance to the nearest airport increases as the distance to the nearest HSR station increases. As shown in Table 9 for total trip distances greater than 300 miles, the increasing HSR mode shares as distance to a HSR station increases result from shifts in trips from air travel to HSR; auto mode shares remain relatively constant for the access distance ranges up to 75 miles.

While some questions regarding the mode share patterns shown in Tables 9a and 9b may still exist, the information and analysis presented demonstrate the complexity of the HSR Model. We also suggest that the results of the analysis continue to demonstrate the general reasonability of the HSR Model. The tables presented in the original draft of this memorandum did not stratify the trips by distance range of the overall trip. The resulting HSR mode share patterns were mixed and, in general, showed increasing mode shares as access distances to the selected HSR stations increased. The "simple" summary presented in the original draft of this memorandum masked some of the interactions between modes that are more apparent in the summaries provided in Tables 9a and 9b.

b. Tables of own- and cross-elasticities by mode for the time and cost variables across the state, by origin-destination distance or inter-regional pairs, by income group and distance band from the HSR stations

The elasticity analyses shown below was presented to the Peer Review Panel during the May 19 conference call. The analyses show that the HSR Model demonstrates very reasonable self- and cross-elasticities.

Elasticity Study Procedures

Model elasticities were evaluated by changing one input variable at a time. Two different base scenarios were used for the analyses: the 2030 no-build scenario and the 2030 full high speed rail scenario. In general, alternative scenario test runs were performed by simply factoring input impedance matrices by set factors. For example, for the analysis of self and cross elasticities for auto travel time, the input travel times for each interchange used for the base run were simply multiplied by a factor (e.g. 0.50) and the resulting travel times were input into the travel model. Table 10 summarizes the test runs performed.

The hierarchical structure of the HSR model made it impossible to isolate the impacts of variable changes to one model component. The changes in forecasted travel by mode also included components of change due to destination choice and trip frequency. To lessen this issue, elasticities were estimated using two different measures of the change in trips resulting from a change in the input variables:

- Change in absolute number of trips by mode. Elasticities based on this quantity measure included the full impact of the changes in destination choice and trip frequency.
- Change in mode shares. The impact of changes in trip frequency were reduced somewhat in this measure through normalization of the total quantity. The effects of changes in destination choice were still fully included in elasticities calculated using this quantity measure.

Table 10. Elasticity Analysis Test Runs

		Level of Service Test	
Run Designation	**Base Scenario**	**Variable Changed**	**Percentage Change from Base**
S1_fuelcost100p	No-Build	Fuel Cost	100%
S2_fuelcost200p	No-Build	Fuel Cost	200%
S17_fuelcost-50p	No-Build	Fuel Cost	-50%
S3_autott25p	No-Build	Auto Travel Time	25%
S4_autott50p	No-Build	Auto Travel Time	50%
S5_airfare-25p	No-Build	Airfare	-25%
S6_airfare33p	No-Build	Airfare	33%
S7_airhdwy-25p	No-Build	Air Headway	-25%
S8_airhdwy25p	No-Build	Air Headway	25%
S9_cvrhdwy-25p	No-Build	CVR Headway	-25%
S10_cvrhdwy25p	No-Build	CVR Headway	25%
S11_hsrfare-25p	Build	HSR Fare	-25%
S12_hsrfare25p	Build	HSR Fare	25%
S13_hsrtt33p	Build	HSR Travel Time	33%
S14_hsrtt50p	Build	HSR Travel Time	50%
S15_hsrhdwy25p	Build	HSR Headway	25%
S16_hsrhdwy33p	Build	HSR Headway	33%

Different methods may be used to calculate the elasticity measures. Since elasticity is, by definition, a point measure, an exact method for determining elasticity is to take the derivative of the demand curve. Unfortunately, such an approach is rarely an option with travel demand models and forecasts. The log arc elasticity formula has been identified as the measure that most closely replicates point elasticity and will be used for elasticity calculations in this analysis.

Log Arc Elasticity Formula

$$\eta = \frac{\Delta LN(Q)}{\Delta LN(P)} = \frac{LN(Q_2) - LN(Q_1)}{LN(P_2) - LN(P_1)}$$

Elasticities Based on Overall Model Results

Table 11 summarizes the total trips and mode shares for the no-build and base model runs and for the elasticity test runs. Table 12 summarizes the log arc elasticities based on the information presented in Table 11. The elasticities based on total trips in Table 12 include elasticities for the change in the total trips modeled for the scenario. Those elasticities are, in effect, elasticities for the trip frequency models. The elasticities and the changes in total trips from the base show that the trip frequency model is indeed affected by accessibility as measured by logsums. A reasonable expectation is that better levels of service indicated by travel conditions should lead to a higher frequency of trip making. This effect includes improved LOS in existing modes and the addition of a new mode. If LOS drops, we should expect fewer trips.

Overall trip making observations

- Changes in fuel costs cause changes in the correct direction. The model does not appear to be overly sensitive to these changes.

- Increases in auto travel times cause an increase in interregional trip making. This is a counterintuitive result that needs additional investigation. While we don't yet have an explanation for why an increase in auto travel times might produce an increase in interregional trips, the scenarios tested are pretty unreasonable in magnitude and coverage (unless, for example, the 55 MPH speed limit law is reintroduced and enforced in California). Changes in travel times for specific region-to-region movements more likely to occur and these changes are more likely to be smaller in magnitude than the 25 and 50 percent increases in travel times used for the elasticity tests. Changes in region-to-region auto travel times will cause destination choice changes that may have more impact on travel than the overall trip frequency changes noted in the elasticity tests. Thus, although the counterintuitive results merit additional investigation, the magnitude of the impact on overall trip making should be small.

- Changes in the levels of service for public modes cause almost no change in total travel. However, the changes in travel resulting from changes in levels of service for public modes are in the correct directions.

- The introduction of high-speed rail causes a relatively small change in overall travel. In the scenarios shown, the base build alternative produced only 1,290 trips, or 0.05

percent, more than the no-build alternative. This result may appear to be contradictory to reports that three to ten percent of high speed rail ridership is from induced travel. The apparent contradiction occurs from the inclusion of ridership resulting from changes in destination choice in the induced travel reported for high-speed rail. Thus, the real contradiction is in the definitions of induced ridership.

Travel by mode observations

- FUEL COST: Overall, auto travel is rather inelastic with respect to changes in fuel cost. Cross elasticities for air and conventional rail appear "large" due to the number of auto trips in comparison to the number of air and conventional rail trips.

- AUTO TRAVEL TIME: Despite an increase in travel times, auto trips increase marginally. Logic dictates that increases in auto travel time should decrease auto travel; the elasticity should be negative, not positive. This counterintuitive result is likely caused by the unrealistically high and general (rather than localized) increase in total trip making noted previously.

  Elasticities based on changes in mode shares (minimizing the effects of the trip frequency model) show the expected negative signs – increases in auto travel times decrease auto mode shares.

  Cross-elasticities for air and conventional rail are high. As with the changes in fuel prices, the high cross-elasticities are probably due to the large number of auto trips in comparison to the trips by air and conventional rail.

- AIR FARE: Self-elasticities with respect to air fare changes have the correct sign. The elasticities are substantially higher than those for fuel prices although they are still inelastic.

  Almost all of the changes in air travel are absorbed by the auto mode although air and conventional rail are in same nest in the mode choice structure. However, there is very little competition between air travel and conventional rail due to the sparseness of the conventional rail service.

- AIR HEADWAY: The air headway elasticity is approximately -0.2. As with air fares, there is almost no change in conventional rail ridership due to the lack of real competition between the two modes.

- RAIL HEADWAY: Elasticities for rail headways are about three times those for air headways.

High speed rail observations

- BUILD to NO BUILD: In comparison to the no-build alternative, high speed rail draws proportionately fewer travelers from auto than from either air or conventional rail.

High speed rail draws proportionately more travelers from AIR than from CVR since it competes more directly with air service.

- HSR FARE: Self-elasticities for high speed rail fares are similar to those noted for air fares. Cross elasticities are greatest for air, then conventional rail, and then auto. This pattern also appears reasonable given the types of service offered..
- HSR TRAVEL TIME: Self-elasticity to travel time is very high in comparison to those noted for other modes. The largest cross-elasticity is with air, reflecting the more direct competition with that mode.
- HSR HEADWAY: High speed rail headway elasticities are similar in magnitude to those noted for air. The headway elasticities for high speed rail are substantially lower than the travel time elasticities.

Elasticities for Base Auto Share Ranges

Trips were summarized into subgroups based on auto mode shares for the base no-build scenario. This special summary provides information on the variability of elasticities by the location on the demand curve. Table 13 summarizes the log arc self-elasticities and cross-elasticities for auto for the various sensitivity tests. The base auto mode share for an interchange has a substantial impact on the self-elasticities and cross-elasticities for the interchange. Interchanges with low base auto mode shares have high self-elasticities and interchanges with high base auto mode shares have low self-elasticities.

Elasticities by Trip Purpose

Tables 14 and 15 summarize the log arc elasticities for the combined business-commute trip purposes and the combined recreation-other trip purposes. Self-elasticities and cross-elasticities for fares for public transport modes are generally greater in absolute magnitude for recreation-other trips than for business-commute trips. This probably reflects the impact of larger group sizes and the need to purchase multiple tickets for recreation-other trips leading to increased willingness to switch modes based on changes in fares. Likewise, recreation-other elasticities for time-related travel components are generally less in absolute magnitude than those for business-commute trips. This finding, also, is consistent with what would be expected for recreation-other trips in comparison to business-commute trips.

Elasticities by Trip Distance

Tables 16 and 17 summarize the log arc elasticities for short distance (less than 100 miles) and long distance (100 miles or greater) trips. Self-elasticities and cross-elasticities for fares for the auto mode modes are generally greater in absolute magnitude for long distance trips than for short distance trips. This probably reflects the impact of base mode shares as demonstrated in Table 13. Long distance auto mode shares are in the 70 to 90 percent range while short distance auto mode shares are in the 90 to 99 percent range.

Table 11. Total Trips and Mode Shares for Elasticity Tests

	Change		Total Trips by Mode					Trip Difference from Base	Mode Share			
	Level of Service	Percentage	Auto	Air	HSR	CVR	Total		Auto	Air	HSR	CVR
No-Build Conditions	**Base**	**–**	**2,342,899**	**88,330**	**0**	**62,630**	**2,493,859**	**–**	**93.9%**	**3.5%**	**0.0%**	**2.5%**
S1_fuelcost100p	Fuel Cost	100%	2,184,740	129,297	0	118,974	2,433,011	-2.4%	89.8%	5.3%	0.0%	4.9%
S2_fuelcost200p	Fuel Cost	200%	2,010,625	158,286	0	211,112	2,380,023	-4.6%	84.5%	6.7%	0.0%	8.9%
S17_fuelcost-50p	Fuel Cost	-50%	2,416,398	65,808	0	45,179	2,527,385	1.3%	95.6%	2.6%	0.0%	1.8%
S3_autott25p	Auto Travel Time	25%	2,353,873	129,189	0	104,208	2,587,271	3.7%	91.0%	5.0%	0.0%	4.0%
S4_autott50p	Auto Travel Time	50%	2,351,535	167,711	0	157,904	2,677,150	7.3%	87.8%	6.3%	0.0%	5.9%
S5_airfare-25p	Airfare	-25%	2,328,702	102,772	0	62,521	2,493,996	0.0%	93.4%	4.1%	0.0%	2.5%
S6_airfare33p	Airfare	33%	2,360,768	70,219	0	62,735	2,493,723	0.0%	94.7%	2.8%	0.0%	2.5%
S7_airhdwy-25p	Air Headway	-25%	2,338,640	92,640	0	62,598	2,493,879	0.0%	93.8%	3.7%	0.0%	2.5%
S8_airhdwy25p	Air Headway	25%	2,346,904	84,277	0	62,659	2,493,840	0.0%	94.1%	3.4%	0.0%	2.5%
S9_cvrhdwy-25p	CVR Headway	-25%	2,333,875	88,284	0	71,876	2,494,035	0.0%	93.6%	3.5%	0.0%	2.9%
S10_cvrhdwy25p	CVR Headway	25%	2,350,811	88,368	0	54,535	2,493,714	0.0%	94.3%	3.5%	0.0%	2.2%
Build Conditions	**Base**	**–**	**2,191,059**	**52,435**	**201,806**	**49,849**	**2,495,149**	**–**	**87.8%**	**2.1%**	**8.1%**	**2.0%**
S11_hsrfare-25p	HSR Fare	-25%	2,166,752	47,115	234,883	46,802	2,495,552	0.0%	86.8%	1.9%	9.4%	1.9%
S12_hsrfare25p	HSR Fare	25%	2,212,277	57,822	172,300	52,448	2,494,848	0.0%	88.7%	2.3%	6.9%	2.1%
S13_hsrtt33p	HSR Travel Time	33%	2,224,382	63,999	152,912	53,559	2,494,852	0.0%	89.2%	2.6%	6.1%	2.1%
S14_hsrtt50p	HSR Travel Time	50%	2,239,409	68,812	131,579	54,932	2,494,731	0.0%	89.8%	2.8%	5.3%	2.2%
S15_hsrhdwy25p	HSR Headway	25%	2,198,292	53,818	192,307	50,649	2,495,066	0.0%	88.1%	2.2%	7.7%	2.0%
S16_hsrhdwy33p	HSR Headway	33%	2,200,497	54,248	189,405	50,893	2,495,042	0.0%	88.2%	2.2%	7.6%	2.0%

Table 12. Log Arc Elasticities for Total Trips and Mode Shares

	Change		Log Arc Elasticities Based on Changes in Total Trips					Trip Difference from Base	Log Arc Elasticities Based on Changes in Mode Shares			
	Level of Service	Percentage	Auto	Air	HSR	CVR	Total		Auto	Air	HSR	CVR
No-Build Conditions	Base	–										
S1_fuelcost100p	Fuel Cost	100%	-0.10	0.55		0.93	-0.04	-2.4%	-0.07	0.59		0.96
S2_fuelcost200p	Fuel Cost	200%	-0.14	0.53		1.11	-0.04	-4.6%	-0.10	0.57		1.15
S17_fuelcost-50p	Fuel Cost	-50%	-0.04	0.42		0.47	-0.02	1.3%	-0.03	0.44		0.49
S3_autott25p	Auto Travel Time	25%	0.02	1.70		2.28	0.16	3.7%	-0.14	1.54		2.12
S4_autott50p	Auto Travel Time	50%	0.01	1.58		2.28	0.17	7.3%	-0.17	1.41		2.11
S5_airfare-25p	Airfare	-25%	0.02	-0.53		0.01	0.00	0.0%	0.02	-0.53		0.01
S6_airfare33p	Airfare	33%	0.03	-0.80		0.01	0.00	0.0%	0.03	-0.80		0.01
S7_airhdwy-25p	Air Headway	-25%	0.01	-0.17		0.00	0.00	0.0%	0.01	-0.17		0.00
S8_airhdwy25p	Air Headway	25%	0.01	-0.21		0.00	0.00	0.0%	0.01	-0.21		0.00
S9_cvrhdwy-25p	CVR Headway	-25%	0.01	0.00		-0.48	0.00	0.0%	0.01	0.00		-0.48
S10_cvrhdwy25p	CVR Headway	25%	0.02	0.00		-0.62	0.00	0.0%	0.02	0.00		-0.62
Build Conditions	Base	–										
S11_hsrfare-25p	HSR Fare	-25%	0.04	0.37	-0.53	0.22	0.00	0.0%	0.04	0.37	-0.53	0.22
S12_hsrfare25p	HSR Fare	25%	0.04	0.44	-0.71	0.23	0.00	0.0%	0.04	0.44	-0.71	0.23
S13_hsrtt33p	HSR Travel Time	33%	0.05	0.70	-0.97	0.25	0.00	0.0%	0.05	0.70	-0.97	0.25
S14_hsrtt50p	HSR Travel Time	50%	0.05	0.67	-1.05	0.24	0.00	0.0%	0.05	0.67	-1.05	0.24
S15_hsrhdwy25p	HSR Headway	25%	0.01	0.12	-0.22	0.07	0.00	0.0%	0.01	0.12	-0.22	0.07
S16_hsrhdwy33p	HSR Headway	33%	0.02	0.12	-0.22	0.07	0.00	0.0%	0.02	0.12	-0.22	0.07

Shaded cells designate self-elasticities.

Table 13. Auto Log Arc Elasticities (Based on Mode Shares)

	Change		Base Auto Mode Share Percent			
	Level of Service	Percentage	0% - 25%	25% - 50%	50% - 75%	75% - 100%
No-Build Conditions						
S1_fuelcost100p	Fuel Cost	100%	-2.34	-1.68	-0.72	-0.04
S2_fuelcost200p	Fuel Cost	200%	-2.69	-2.02	-0.97	-0.07
S17_fuelcost-50p	Fuel Cost	-50%	-1.08	-0.59	-0.23	-0.01
S3_autott25p	Auto Travel Time	25%	-4.79	-3.31	-1.50	-0.08
S4_autott50p	Auto Travel Time	50%	-5.14	-3.70	-1.68	-0.11
S5_airfare-25p	Airfare	-25%	1.52	1.06	0.28	0.00
S6_airfare33p	Airfare	33%	1.89	1.12	0.28	0.00
S7_airhdwy-25p	Air Headway	-25%	0.31	0.23	0.08	0.00
S8_airhdwy25p	Air Headway	25%	0.40	0.29	0.10	0.00
S9_cvrhdwy-25p	CVR Headway	-25%	0.00	0.01	0.09	0.01
S10_cvrhdwy25p	CVR Headway	25%	0.00	0.02	0.11	0.01
Build Conditions						
S11_hsrfare-25p	HSR Fare	-25%	0.66	0.37	0.17	0.02
S12_hsrfare25p	HSR Fare	25%	0.78	0.44	0.19	0.02
S13_hsrtt33p	HSR Travel Time	33%	1.11	0.74	0.24	0.02
S14_hsrtt50p	HSR Travel Time	50%	1.12	0.73	0.24	0.02
S15_hsrhdwy25p	HSR Headway	25%	0.16	0.15	0.06	0.01
S16_hsrhdwy33p	HSR Headway	33%	0.17	0.16	0.06	0.01

Shaded cells designate self-elasticities.

Table 14. Log Arc Elasticities for Total Business-Commute Trips and Mode Shares

	Change		Log Arc Elasticities Based on Changes in Total Trips					Trip Difference from Base	Log Arc Elasticities Based on Changes in Mode Shares			
	Level of Service	Percentage	Auto	Air	HSR	CVR	Total		Auto	Air	HSR	CVR
No-Build Conditions	**Base**	–										
S1_fuelcost100p	Fuel Cost	100%	-0.08	0.37		0.94	-0.01	-0.6%	-0.07	0.38		0.95
S2_fuelcost200p	Fuel Cost	200%	-0.13	0.40		1.11	-0.01	-1.1%	-0.12	0.41		1.12
S17_fuelcost-50p	Fuel Cost	-50%	-0.03	0.23		0.49	-0.01	0.3%	-0.03	0.23		0.49
S3_autott25p	Auto Travel Time	25%	-0.05	1.96		2.57	0.17	3.9%	-0.22	1.79		2.40
S4_autott50p	Auto Travel Time	50%	-0.08	1.77		2.53	0.18	7.7%	-0.26	1.59		2.34
S5_airfare-25p	Airfare	-25%	0.01	-0.31		0.01	0.00	0.0%	0.01	-0.31		0.01
S6_airfare33p	Airfare	33%	0.02	-0.44		0.01	0.00	0.0%	0.02	-0.44		0.01
S7_airhdwy-25p	Air Headway	-25%	0.01	-0.19		0.00	0.00	0.0%	0.01	-0.19		0.00
S8_airhdwy25p	Air Headway	25%	0.01	-0.24		0.00	0.00	0.0%	0.01	-0.24		0.00
S9_cvrhdwy-25p	CVR Headway	-25%	0.02	0.00		-0.52	0.00	0.0%	0.02	0.00		-0.52
S10_cvrhdwy25p	CVR Headway	25%	0.02	0.00		-0.67	0.00	0.0%	0.02	0.00		-0.67
Build Conditions	**Base**	–										
S11_hsrfare-25p	HSR Fare	-25%	0.03	0.18	-0.51	0.23	0.00	0.0%	0.03	0.18	-0.51	0.23
S12_hsrfare25p	HSR Fare	25%	0.03	0.20	-0.63	0.24	0.00	0.0%	0.03	0.20	-0.63	0.24
S13_hsrtt33p	HSR Travel Time	33%	0.05	0.59	-1.37	0.27	0.00	0.0%	0.05	0.59	-1.37	0.27
S14_hsrtt50p	HSR Travel Time	50%	0.05	0.55	-1.48	0.26	0.00	0.0%	0.05	0.55	-1.48	0.26
S15_hsrhdwy25p	HSR Headway	25%	0.01	0.11	-0.29	0.08	0.00	0.0%	0.01	0.11	-0.29	0.08
S16_hsrhdwy33p	HSR Headway	33%	0.01	0.11	-0.30	0.08	0.00	0.0%	0.01	0.11	-0.30	0.08

Shaded cells designate self-elasticities.

Table 15. Log Arc Elasticities for Total Recreation-Other Trips and Mode Shares

	Change		Log Arc Elasticities Based on Changes in Total Trips					Trip Difference from Base	Log Arc Elasticities Based on Changes in Mode Shares			
	Level of Service	Percentage	Auto	Air	HSR	CVR	Total		Auto	Air	HSR	CVR
No-Build Conditions	**Base**	–										
S1_fuelcost100p	Fuel Cost	100%	-0.12	0.75		0.89	-0.07	-4.5%	-0.06	0.82		0.95
S2_fuelcost200p	Fuel Cost	200%	-0.15	0.67		1.10	-0.08	-8.4%	-0.07	0.75		1.18
S17_fuelcost-50p	Fuel Cost	-50%	-0.06	0.72		0.42	-0.04	2.5%	-0.03	0.75		0.46
S3_autott25p	Auto Travel Time	25%	0.10	1.36		1.09	0.16	3.6%	-0.06	1.20		0.93
S4_autott50p	Auto Travel Time	50%	0.10	1.31		1.16	0.17	7.0%	-0.07	1.15		0.99
S5_airfare-25p	Airfare	-25%	0.03	-0.78		0.01	0.00	0.0%	0.03	-0.78		0.01
S6_airfare33p	Airfare	33%	0.04	-1.32		0.01	0.00	0.0%	0.04	-1.32		0.01
S7_airhdwy-25p	Air Headway	-25%	0.00	-0.13		0.00	0.00	0.0%	0.00	-0.13		0.00
S8_airhdwy25p	Air Headway	25%	0.01	-0.17		0.00	0.00	0.0%	0.01	-0.17		0.00
S9_cvrhdwy-25p	CVR Headway	-25%	0.00	0.00		-0.34	0.00	0.0%	0.00	0.00		-0.34
S10_cvrhdwy25p	CVR Headway	25%	0.01	0.00		-0.44	0.00	0.0%	0.01	0.00		-0.44
Build Conditions	**Base**	–										
S11_hsrfare-25p	HSR Fare	-25%	0.05	0.77	-0.54	0.19	0.00	0.0%	0.05	0.77	-0.54	0.19
S12_hsrfare25p	HSR Fare	25%	0.06	0.85	-0.77	0.20	0.00	0.0%	0.06	0.85	-0.76	0.20
S13_hsrtt33p	HSR Travel Time	33%	0.06	0.90	-0.73	0.17	0.00	0.0%	0.06	0.90	-0.73	0.17
S14_hsrtt50p	HSR Travel Time	50%	0.06	0.89	-0.80	0.17	0.00	0.0%	0.06	0.89	-0.80	0.18
S15_hsrhdwy25p	HSR Headway	25%	0.02	0.13	-0.17	0.05	0.00	0.0%	0.02	0.13	-0.17	0.05
S16_hsrhdwy33p	HSR Headway	33%	0.02	0.14	-0.17	0.05	0.00	0.0%	0.02	0.14	-0.17	0.05

Shaded cells designate self-elasticities.

Table 16. Log Arc Elasticities for Total Short Distance Trips and Mode Shares

	Change		Log Arc Elasticities Based on Changes in Total Trips					Trip Difference from Base	Log Arc Elasticities Based on Changes in Mode Shares			
	Level of Service	Percentage	Auto	Air	HSR	CVR	Total		Auto	Air	HSR	CVR
No-Build Conditions	**Base**	–										
S1_fuelcost100p	Fuel Cost	100%	-0.09	–	–	1.14	-0.05	-3.4%	-0.04	–	–	1.19
S2_fuelcost200p	Fuel Cost	200%	-0.14	–	–	1.33	-0.06	-6.4%	-0.08	–	–	1.39
S17_fuelcost-50p	Fuel Cost	-50%	-0.04	–	–	0.62	-0.03	1.9%	-0.01	–	–	0.64
S3_autott25p	Auto Travel Time	25%	0.07	–	–	2.17	0.12	2.8%	-0.06	–	–	2.04
S4_autott50p	Auto Travel Time	50%	0.06	–	–	2.10	0.13	5.5%	-0.07	–	–	1.97
S5_airfare-25p	Airfare	-25%	0.00	–	–	0.00	0.00	0.0%	0.00	–	–	0.00
S6_airfare33p	Airfare	33%	0.00	–	–	0.00	0.00	0.0%	0.00	–	–	0.00
S7_airhdwy-25p	Air Headway	-25%	0.00	–	–	0.00	0.00	0.0%	0.00	–	–	0.00
S8_airhdwy25p	Air Headway	25%	0.00	–	–	0.00	0.00	0.0%	0.00	–	–	0.00
S9_cvrhdwy-25p	CVR Headway	-25%	0.01	–	–	-0.53	0.00	0.0%	0.01	–	–	-0.53
S10_cvrhdwy25p	CVR Headway	25%	0.01	–	–	-0.69	0.00	0.0%	0.01	–	–	-0.69
Build Conditions	**Base**	–										
S11_hsrfare-25p	HSR Fare	-25%	0.02	–	-1.18	0.26	0.00	0.0%	0.02	–	-1.18	0.26
S12_hsrfare25p	HSR Fare	25%	0.01	–	-1.52	0.27	0.00	0.0%	0.01	–	-1.52	0.27
S13_hsrtt33p	HSR Travel Time	33%	0.01	–	-0.99	0.24	0.00	0.0%	0.01	–	-0.99	0.24
S14_hsrtt50p	HSR Travel Time	50%	0.01	–	-1.01	0.22	0.00	0.0%	0.01	–	-1.01	0.22
S15_hsrhdwy25p	HSR Headway	25%	0.00	–	-0.37	0.07	0.00	0.0%	0.00	–	-0.37	0.07
S16_hsrhdwy33p	HSR Headway	33%	0.00	–	-0.38	0.07	0.00	0.0%	0.00	–	-0.38	0.07

Shaded cells designate self-elasticities.

Table 17. Log Arc Elasticities for Total Long Distance Trips and Mode Shares

	Change		Log Arc Elasticities Based on Changes in Total Trips					Trip Difference from Base	Log Arc Elasticities Based on Changes in Mode Shares			
	Level of Service	Percentage	Auto	Air	HSR	CVR	Total		Auto	Air	HSR	CVR
No-Build Conditions	**Base**	–										
S1_fuelcost100p	Fuel Cost	100%	-0.12	0.55	–	0.51	0.00	-0.3%	-0.12	0.55	–	0.52
S2_fuelcost200p	Fuel Cost	200%	-0.14	0.53	–	0.61	0.00	-0.5%	-0.14	0.54	–	0.61
S17_fuelcost-50p	Fuel Cost	-50%	-0.06	0.42	–	0.27	0.00	0.2%	-0.06	0.43	–	0.28
S3_autott25p	Auto Travel Time	25%	-0.09	1.70	–	2.45	0.25	5.7%	-0.34	1.45	–	2.20
S4_autott50p	Auto Travel Time	50%	-0.13	1.58	–	2.53	0.26	11.3%	-0.39	1.32	–	2.26
S5_airfare-25p	Airfare	-25%	0.07	-0.53	–	0.02	0.00	0.0%	0.07	-0.53	–	0.02
S6_airfare33p	Airfare	33%	0.09	-0.80	–	0.01	0.00	0.0%	0.09	-0.80	–	0.02
S7_airhdwy-25p	Air Headway	-25%	0.02	-0.17	–	0.00	0.00	0.0%	0.02	-0.17	–	0.00
S8_airhdwy25p	Air Headway	25%	0.03	-0.21	–	0.01	0.00	0.0%	0.03	-0.21	–	0.01
S9_cvrhdwy-25p	CVR Headway	-25%	0.02	0.00	–	-0.40	0.00	0.0%	0.02	0.00	–	-0.40
S10_cvrhdwy25p	CVR Headway	25%	0.02	0.00	–	-0.52	0.00	0.0%	0.02	0.00	–	-0.52
Build Conditions	**Base**	–										
S11_hsrfare-25p	HSR Fare	-25%	0.11	0.37	-0.43	0.14	0.00	0.0%	0.11	0.37	-0.42	0.14
S12_hsrfare25p	HSR Fare	25%	0.13	0.44	-0.61	0.16	0.00	0.0%	0.13	0.44	-0.61	0.16
S13_hsrtt33p	HSR Travel Time	33%	0.19	0.70	-0.97	0.28	0.00	0.0%	0.19	0.70	-0.97	0.28
S14_hsrtt50p	HSR Travel Time	50%	0.19	0.67	-1.06	0.27	0.00	0.0%	0.19	0.67	-1.06	0.27
S15_hsrhdwy25p	HSR Headway	25%	0.05	0.12	-0.19	0.07	0.00	0.0%	0.05	0.12	-0.19	0.07
S16_hsrhdwy33p	HSR Headway	33%	0.05	0.12	-0.20	0.07	0.00	0.0%	0.05	0.12	-0.20	0.07

Shaded cells designate self-elasticities.

c. A brief assessment of access and egress mode shares (and parking demand in particular) detailed appropriately by HSR station

Tables 18 and 19 provide information on the access mode shares to HSR stations and egress mode shares from HSR stations. The raw HSR Model output has been summarized directly from interregional model results, but includes results for both short and long distance travel. The access and egress mode choice models were not calibrated to as close a tolerance as the other HSR Model components since the access and egress models are used solely to provide logsums for access and egress to the main mode choice models. In addition, in the final HSR Model validation documentation, it was noted that access and egress mode shares for validation were derived from the estimation dataset and, as a result, were not as accurate in the aggregate as an independent validation data source of trips would have been.

Tables 18 and 19 also provide results from the access/egress post-processor developed for the project. The access/egress post-processor assigns each station to one of several prototype categories based on its location in the region, the density and urban form around the station, and the likely parking cost. Observed data from existing train stations and airports along with information from national reports are used to estimate access and egress mode shares along with parking duration. In addition, the access/egress post-processor considers trips from both the intraregional and interregional models. Table 20 shows the results of the parking duration and parking demand calculations for the 2030 HSR alternative.

d. Analysis of the effects on forecasts of expert judgments that were made to override estimated model coefficients

Perhaps the most discussed override of estimated HSR Model coefficients was the decision to constrain the service headway coefficient to be equal to the in-vehicle travel time coefficient for each trip purpose. This had the effects of increasing the magnitude of the service coefficients by factors of four or five and making travel forecasts more sensitive to changes in service frequency.

Service frequency is a variable for only the public modes – air, CVR, and HSR. If the service frequency coefficients were about twenty percent of their constrained sizes as originally estimated, the HSR Model would produce higher mode shares for air, CVR, and HSR in the absence of model constant recalibration.

Work on the peer review panel's requests for additional analysis under Task 4 is proceeding. The analysis may provide additional insights on the impacts of the coefficient constraints.

Table 18. Access Mode Share Assessment

	Raw Model Output–Interregional Trips			Access/Egress Post-Processor–All Trips		
Station Name	**Auto**	**Transit**	**Other**	**Auto**	**Transit**	**Other**
San Francisco (Transbay)	71%	24%	5%	43%	27%	30%
Millbrae	83%	8%	9%	56%	23%	21%
Redwood City	90%	6%	4%	76%	11%	13%
San Jose	84%	10%	5%	55%	23%	21%
Gilroy	98%	0%	2%	93%	4%	3%
Sacramento	98%	1%	1%	53%	25%	22%
Stockton	98%	0%	2%	83%	11%	6%
Modesto/SP Downtown	96%	0%	4%	84%	10%	6%
Merced	95%	0%	5%	86%	9%	5%
Fresno	98%	0%	2%	85%	10%	6%
Bakersfield	93%	5%	1%	86%	9%	5%
Palmdale	97%	1%	2%	93%	4%	3%
Sylmar	94%	5%	1%	93%	4%	3%
Burbank	80%	13%	7%	77%	10%	13%
Los Angeles Union Station	73%	24%	3%	44%	27%	29%
Norwalk	87%	12%	1%	73%	13%	14%
Anaheim	84%	16%	1%	70%	15%	14%
City of Industry	91%	8%	1%	93%	4%	3%
Ontario	98%	0%	2%	77%	10%	13%
Riverside	99%	0%	1%	89%	8%	4%
Temecula / Murrieta	98%	0%	2%	95%	2%	3%
Escondido	94%	4%	2%	76%	11%	13%
University City	96%	0%	4%	95%	2%	3%
San Diego	82%	15%	3%	57%	22%	21%
Total	**88%**	**9%**	**3%**	**70%**	**15%**	**15%**

Table 19. Egress Mode Share Assessment

Station Name	Raw Model Output–Interregional Trips Auto	Transit	Other	Access/Egress Post-Processor–All Trips Auto	Transit	Other
San Francisco (Transbay)	79%	17%	4%	43%	27%	30%
Millbrae	87%	6%	7%	56%	23%	21%
Redwood City	92%	5%	3%	76%	11%	13%
San Jose	88%	8%	4%	55%	23%	21%
Gilroy	99%	0%	1%	93%	4%	3%
Sacramento	98%	1%	1%	53%	25%	22%
Stockton	98%	0%	2%	83%	11%	6%
Modesto/SP Downtown	97%	0%	3%	84%	10%	6%
Merced	97%	0%	3%	86%	9%	5%
Fresno	99%	0%	1%	85%	10%	6%
Bakersfield	97%	2%	1%	86%	9%	5%
Palmdale	99%	1%	1%	93%	4%	3%
Sylmar	97%	3%	1%	93%	4%	3%
Burbank	89%	7%	4%	77%	10%	13%
Los Angeles Union Station	83%	15%	2%	44%	27%	29%
Norwalk	94%	6%	1%	73%	13%	14%
Anaheim	95%	5%	0%	70%	15%	14%
City of Industry	92%	8%	1%	93%	4%	3%
Ontario	98%	0%	1%	77%	10%	13%
Riverside	99%	0%	1%	89%	8%	4%
Temecula / Murrieta	99%	0%	1%	95%	2%	3%
Escondido	96%	2%	1%	76%	11%	13%
University City	97%	1%	2%	95%	2%	3%
San Diego	91%	7%	2%	57%	22%	21%
Total	**98%**	**2%**	**1%**	**70%**	**15%**	**15%**

Table 20. HSR Parking and Auto Access Demand – Access/Egress Post-Processor

Station Name	Station Boardings	Average Daily Parking Accumulation	Average Daily Auto Drop-Offs	Average Daily Rental Car Transactions	Average Daily Taxi Transactions
San Francisco (Transbay)	34,529	6,954	2,246	1,320	1,788
Millbrae	5,719	1,034	598	289	269
Redwood City	7,469	2,792	1,048	406	366
San Jose	12,065	3,426	1,081	552	550
Gilroy	6,440	6,045	1,187	181	321
Sacramento	18,144	7,996	1,397	871	1,049
Stockton	6,323	5,965	949	309	376
Merced	2,449	1,990	377	117	108
Fresno	7,950	6,799	1,206	379	391
Bakersfield	8,090	6,644	1,248	388	364
Palmdale	16,395	10,568	3,228	388	678
Sylmar	12,850	9,189	2,504	224	397
Burbank	4,113	1,380	609	214	181
Los Angeles Union Station	28,066	4,384	2,078	1,116	1,296
Norwalk	6,757	2,901	861	402	392
Anaheim	21,672	13,176	2,359	1,392	1,529
Ontario	10,577	3,639	1,510	666	558
Riverside	13,734	8,025	2,391	710	410
Temecula / Murrieta	7,108	5,202	1,423	91	170
Escondido	7,804	3,947	957	463	398
University City	5,850	5,280	1,080	90	171
San Diego	19,183	6,459	1,587	915	878
City of Industry	6,408	4,216	1,285	125	219
Modesto/SP Downtown	4,367	3,967	656	210	242
Total	274,063	131,979	33,867	11,819	13,099

3. Further checks on model validity requested in final two paragraphs of Task 3.2

The suggestions in this section are less issues with the HSR Model formulation then they are with the input assumptions. The panel notes that these practical considerations are not easily included in a mathematical model and we agree. We are also acutely aware of the work done by Flyvbjerg et al. with respect to the issue of over-estimation of use of major transportation investments.

In response to these concerns, and as we proceed with the business planning phase of the project, we have worked with PB to construct a set of scenarios to reflect different input assumptions, such as:

- Recent trends in point-to-point airfares in California
- Potential competitive responses of airlines both in terms of air fares and frequencies, informed by work we commissioned Dr. Geoff Gosling to provide
- Alternative HSR fare assumptions
- Alternative socioeconomic forecasts
- Alternative assumptions with respect to traveler value of time to be reflected as downward adjustments to the resulting forecasts.

We will also work with PB to develop reasonable assumptions regarding how rapidly service and ridership ramp up to forecast levels. Factors such as service cutbacks due to inadequate funding or operational problems can be picked up in this ramp up analysis—assuming the issues can be characterized as growing pains. Further sensitivity testing to reflect reduced service or speeds over the long term can also be incorporated into a full risk analysis, either through changes to the HSR Model or adjustments to the resulting forecasts.